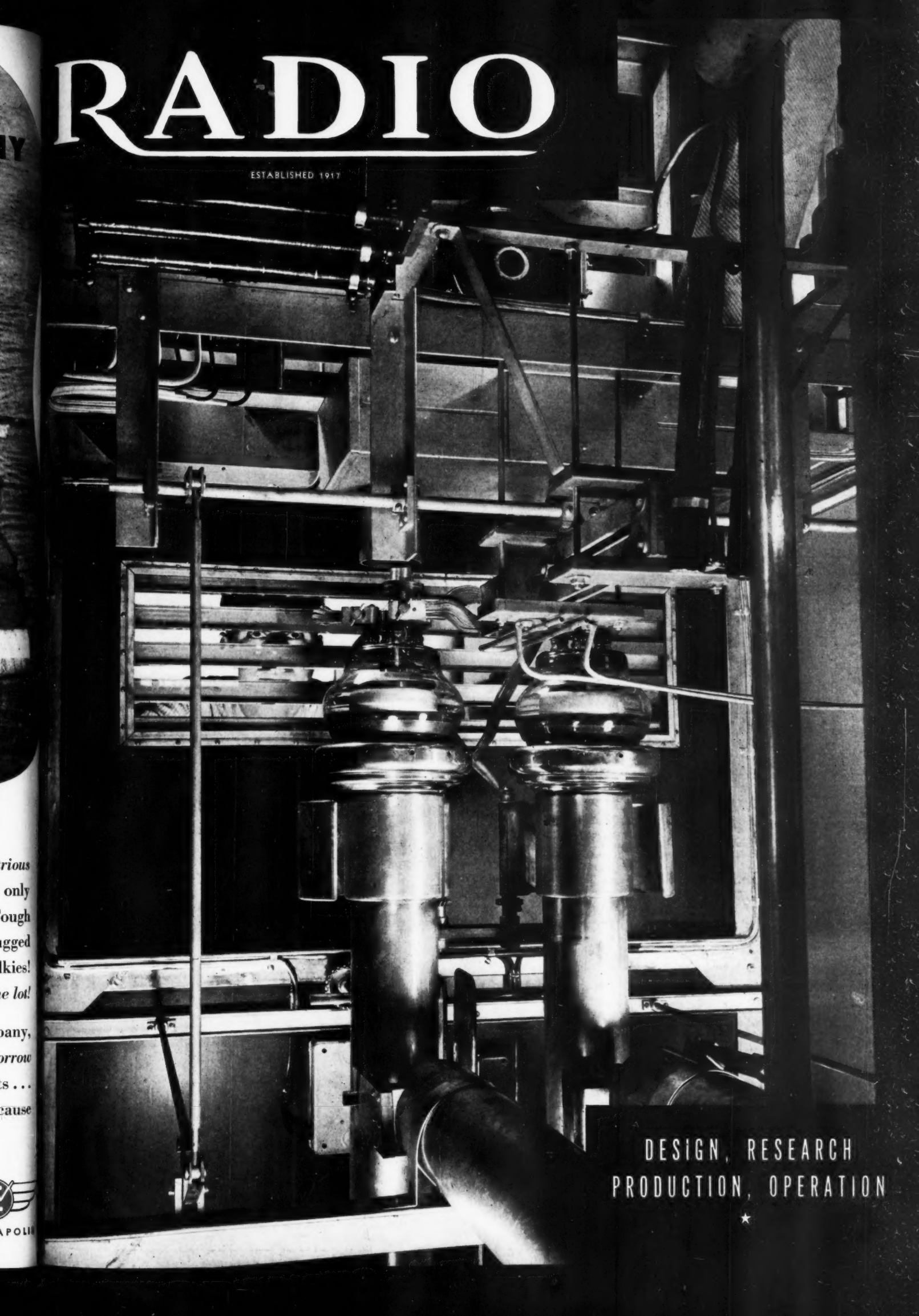


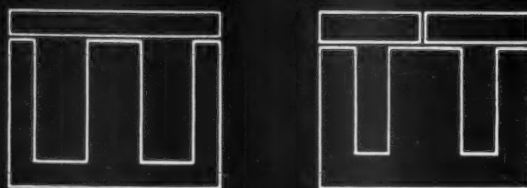
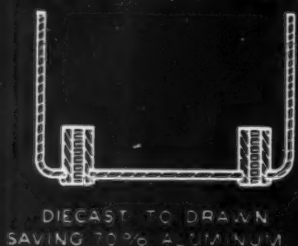
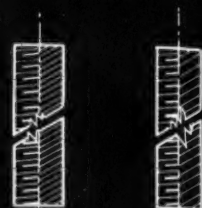
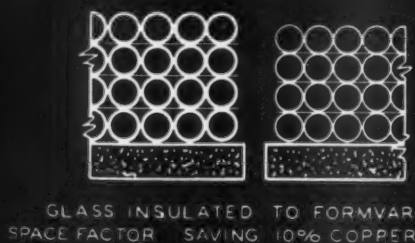
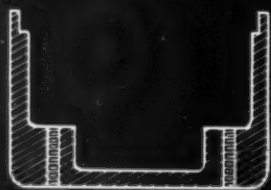
RADIO

ESTABLISHED 1917

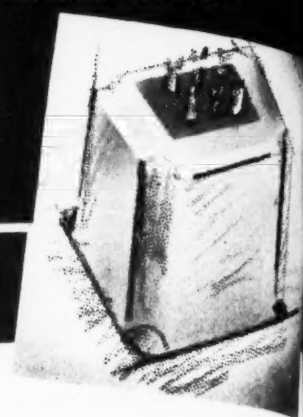


DESIGN, RESEARCH
PRODUCTION, OPERATION





STAINLESS TO PLATED STEEL
SAVING 18% NICKEL



"and it can win or lose the war..."

We all know that our greatest problem today lies in material shortages. The bulk of this problem . . . and it can win or lose the war . . . lies in our hands. A waste of materials, particularly critical materials, in an engineering design today, is as damnable as sabotage.

Here are a few cases in our organization:

1. On one job our redesign combined two pieces of apparatus. The resultant unit, while more efficient, is smaller than either of the individual units. On the basis of projected requirements, the saving in aluminum alone is 500,000 lbs.
2. On this job our delivery schedule would have been delayed five months for the nickel iron core material and shielding cases required. Redesign made possible a unit using silicon core material and silicon shields with actually 10 DB less hum pickup than the original.
3. In this job substitution of a drawn aluminum housing for a die casting effected an aluminum saving of 70%.

Designs must be improved constantly. Take a look at that job you have been running and see whether an extruded rod or a spun bushing won't save the scrap involved in a screw machine part. Check with the Government Engineering Bureau involved as to whether they would not allow a change in material to something lower on the critical list. You will be surprised at their cooperation.

Only when you can say to yourself, "There isn't one of my designs left that can be reduced in amount of material or to less critical materials," can you feel that your share in the War Program is effective.

UNITED TRANSFORMER CO.
150 VARICK STREET ★ NEW YORK, N. Y.

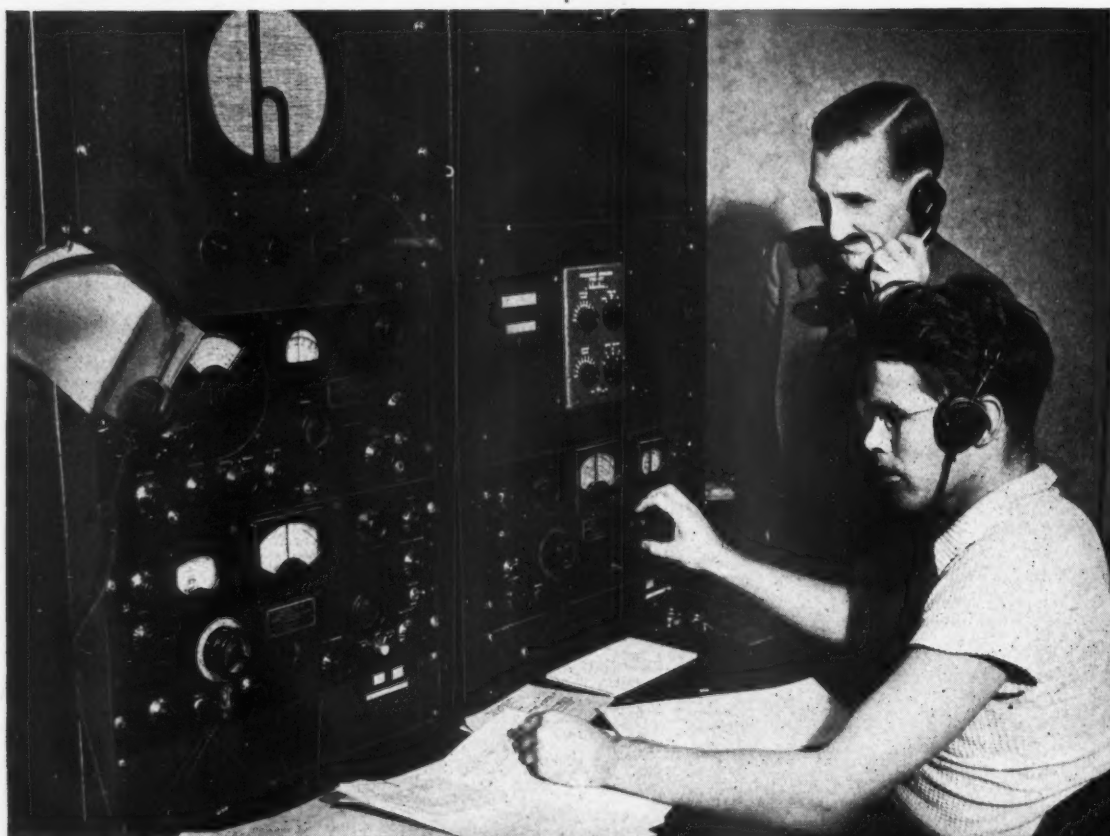
A Better FM Receiver!

... better because Hallicrafters are pioneers in FM. Model S-27 (illustrated) was the first general coverage U.H.F. Communications receiver to incorporate both AM and FM in one receiver. Hallicrafters, through continuous research, both for our armed forces and civilian use, have become the authoritative source for FM Communications receivers.

Hallicrafters Model S-27 FM-AM receiver, 15 tubes, 3 bands, cover 28 to 46 mc., 45 to 84 mc., 81 to 145 mc. Switch changing from FM to AM reception.

hallicrafters
CHICAGO, U.S.A.





Listening Posts!

You will find Hallicrafters Communications Equipment working three shifts at our Country's "Listening Posts"... searching the airways for illegal programs and espionage messages.

Hallicrafters Communications Equipment is engineered to "take it" on this constant operating... there are no rest periods, no-time out, it's constant performance!

The Hallicrafters Equipment you can buy—when communications equipment may again be sold for Civilian use—will incorporate all of the endurance and top quality performance you will ever demand.

Illustration—typical view of Hallicrafters Communications Equipment is a monitoring (listening in) station—somewhere in the U.S.A.

**WORLD'S LARGEST EXCLUSIVE MANUFACTURER OF SHORT WAVE
RADIO COMMUNICATIONS EQUIPMENT**



hallicrafters

CHICAGO, U.S.A.

RADIO

Published by RADIO MAGAZINES, INC.

Editor

M. L. MUHLEMAN

Business Staff

Lee Robinson, Publisher
and President

S. R. Cowan, Business Manager
and Treasurer

M. L. Muhleman, Vice President
and Editor

R. Alan, Circulation Manager

CORRESPONDENCE and ORDERS should be sent only to our New York office. MANUSCRIPTS, if unsolicited and unusable, will not be returned unless accompanied by a stamped, self-addressed envelope.

EXECUTIVE, editorial, and advertising offices of Radio Magazines, Inc., are located at 132 West 43rd Street, New York, N. Y., to which address all correspondence, advertising copy and cuts should be directed.

SUBSCRIPTION RATES (in U. S. funds): Two years, \$5.00, or \$3.00 yearly in U.S.A. To Canada and all foreign countries, \$4.00 yearly. Twelve issues yearly; back issues are not included in subscriptions.

NOTE: Because of wartime censorship restrictions, we must reserve the right to withhold from foreign subscribers any issue the regular domestic edition of which is not approved by the authorities for export without changes. In such cases subscriptions will be extended so that each subscriber will eventually receive the number of issues to which he is entitled.

IF YOU MOVE, notify us in advance; we cannot replace copies sent to your old address. Notice must be received by the 20th of the month preceding the cover date of first issue to go to the new address.

JANUARY 1943

No. 276

Table of Contents

COVER

The final amplifier of Zenith's frequency-modulation station W51C, in the Field Building, Chicago. Note antenna coupling loop and final tank.

ARTICLES

Two and One-half Years' Progress in FM Emergency Equipment— <i>D. Lee Chesnut</i>	15
Elements of Radio Avigation— <i>L. LeKashman</i>	20
Thermal Radio: Heating of Wood With R-F Power— <i>John P. Taylor</i>	23
Radio Design Worksheet: No. 9—Impedance Relations; Coupled Circuits	27
Aircraft Radio Maintenance— <i>Gerald O. Crowley</i>	30
Q. & A. Study Guide: Vacuum Tubes 2— <i>C. Radius</i>	36
Radio Bibliography: 7—Remote Control, Part 3— <i>F. X. Rettenmeyer</i>	39

MISCELLANEOUS

Technicana	6
Editorial	13
This Month (News)	26
New Products	48
Book Review	65
Advertising Index	66

RADIO (title registered U.S. Pat. Off.) is published monthly at 34 N. Crystal Street, East Stroudsburg, Pa., by Radio Magazines, Inc., Executive and Editorial Offices at 132 West 43d Street, New York, N. Y. Subscription rates—United States and Possessions, \$3.00 for 1 year, \$5.00 for 2 years; elsewhere \$4.00 per year. Single copies 35c. Printed in U.S.A. All rights reserved, entire contents Copyright 1943 by Radio Magazines, Inc. Entered as Second Class Matter October 31, 1942, at the Post Office at East Stroudsburg, Pa., under the Act of March 3, 1879.

RADIO

★ JANUARY, 1943

5

for **PERMANENT**
Smooth Control..



OHMITE

All-Ceramic Vitreous-Enameled

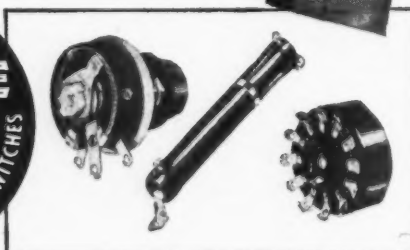
RHEOSTATS

There is a basic difference in Ohmite rheostat design that becomes more and more apparent in actual service . . . a difference in smoothness of action, in long life, in trouble-free performance that means *permanently* smooth, close, electrical control. Every design feature has been time-proved under the most critical conditions, in every climate, on land, at sea and in the air.

This soundness of design, plus the wide range of types and sizes, has made Ohmite Rheostats readily applicable to today's vital needs in war and industry. It also makes them ready to serve in the design of new devices to defeat the enemy and build for tomorrow's peace. Many stock types. Special units engineered for you. Approved types for Army and Navy specifications.

Write on company letterhead for complete, helpful 96-page Catalog and Engineering Manual No. 40.

OHMITE MANUFACTURING CO.
4866 Flournoy St. Chicago, U. S. A.



TECHNICANA

SCHEMATICS

★ The British have an eye for little things that sometimes prove bigger than one would have supposed. The art and technique of drawing schematic diagrams, for instance.

What may or may not prove of some importance in the war effort is contained in a letter from Geoffrey Bocking, appearing in the November 1942 issue of the journal *Electronic Engineering*.

Mr. Bocking is of the opinion that there are certain definite advantages in looped cross-overs as against direct cross-overs in the drawing of circuit diagrams. As a support to this opinion he offers the following practical and psychological points:

1) It is sometimes difficult in printing processes to prevent the possibility of a direct cross-over blurring into a dot, (thus falsely indicating a connection) especially when the diagram is on a reduced scale.

2) In general, a draftsman will tend to omit loops less frequently than he will omit dots, and in the use of looped cross-overs the omission of a dot will be a matter of negligible consequence.

3) In a diagram containing both direct cross-overs and dots the eye tends to "see" dots at every cross-over.

Mr. Bocking concludes with the notation that the results of experiments conducted by workers of the Gestalt school of psychology confirm the last two points.

★

SIGNAL CORPS AMERICANA

★ The criterion of dullness is the knife that "won't cut hot butter." Veterans of World War I might wish to add another example: "Nothing was so dull as the language used in army regulations and instruction books." However, fathers of the American doughboy, Model 1942, would hardly recognize some of the official language now used in military terminology. It sounds human. Leaders of our modern Army have learned that if the maximum amount of training is to be given our soldiers in the minimum of time, it becomes necessary to talk the language of the average soldier.

The Signal Corps has set the example in presenting instruction in plain, every-day Americanese. Instructional pamphlets using cartoons, slang,

[Continued on page 8]



INTELLIGIBILITY

Built to Civil Aeronautics Administration specifications, CAA-515, the Electro-Voice Model 7-A microphone is widely used for airport landing control and is highly suitable for many other sound pick-up applications.

The smooth frequency curve, rising with frequency, gives extremely high intelligibility even under adverse conditions. Desk mounting incorporates easily accessible switch which can be operated by thumb of either right or left hand. Microphone may be moved without danger of pressing this switch.

SPECIFICATIONS

SWITCH: Push-to-talk Acro-switch, SPDT, for relay operation; positive action; slight pressure required for actuation; 1/16" over-travel; connections terminate on terminal strip in base.

OUTPUT IMPEDANCE: 25 ohms.

CABLE: Eight feet, 4 conductor, shielded, overall rubber jacket, equipped with MC4M connector.

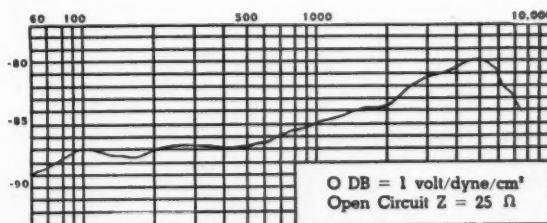
DISTORTION: Not exceeding 5% for sinusoidal sound waves from any direction from 100-4000 cps, up to 50 dynes/cm².

INSULATION: Leads from the moving coil are insulated from the microphone housing and stand, and are capable of withstanding 500 volts RMS, 60 cps.

STAND TUBE: Wear resistant, 1/8" XXM bakelite.

CORROSION RESISTANCE: The entire microphone is completely inhibited against corrosion and will successfully withstand a 20% salt spray atmosphere for 100 hours at 95° F.

NET WEIGHT: 3 1/2 lbs.; Shipping wt.: 5 lbs.



This Model 7-A Desk Mounting Communication Microphone supersedes our previous Model S-7. Our Engineering Department may be able to assist you with your microphone problem. *Electro-Voice Manufacturing Co., Inc.*, 1239 South Bend Avenue, South Bend, Indiana. Export Division: 100 Varick Street, New York, N. Y., U. S. A. — Cable Address: "Arlab"

Electro-Voice MICROPHONES



"BOMBER SQUADRON SIGHTED 20 MILES
SOUTHWEST PREPARE TO INTERCEPT"

HALF *Intelligible Communications*
are not enough . . .

TURNER

Microphones

Faithfully Reproduce
Your Complete Messages

These famous microphones amplify all vibrations received by the diaphragms, without adding any of the harmonics, so you are assured of clear, sharp communications without distortion. Under all climatic and acoustic conditions, you can rely on a Turner.

Choice of 4 Impedances in U9-S

Simply twist the switch on Turner U9-S for your choice of 4 impedances — 50, 200 or 500 ohms or hi-impedance. Here's a dynamic that is free from peaks and holes from 40 to 9,000 cycles, and assures you a perfect job under all conditions. List . . . \$37.50

211 is a Rugged Dynamic

Utilizing a new type magnet structure and acoustic network, 211 has extended the high frequency range and raised extreme lows from 2 to 4 decibels — to compensate for over-all deficiencies in loud speaker systems. A dependable unit for use in war plants, P. A. systems, as well as broadcast studios. List . . . \$45.00

22D Works Indoors or Out

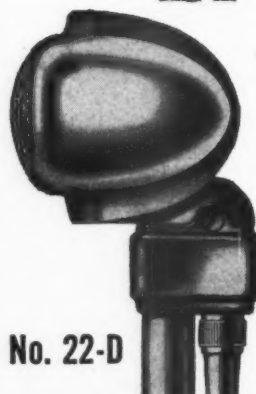
A top-performing general utility mike with high level dynamic cartridge. Reproduces smoothly at all frequencies. Has a range of 40-8,000 cycles, with output of —54DB. Complete with tilting head and 7 ft. removable cable set. Chrome type finish. 200 or 500 ohms or hi-impedance, this 22D is priced at only, List . . . \$23.50



No. U-9S



No. 211



No. 22-D

FREE Turner Microphone Catalog, just off the press with complete information and prices on Turner Microphones. Write for your copy.

Crystals Licensed Under Patents of The Brush Development Co.

THE TURNER CO.

CEDAR RAPIDS, IOWA

TECHNICANA

and typical Yankee terms have been issued to Signal Corps radio operators and maintenance men which supplement the formal, standard Army texts. These pamphlets are in use at Ft. Monmouth, N. J., home of the Signal Corps, and are being issued also to operators and technicians of other arms and services in the field.

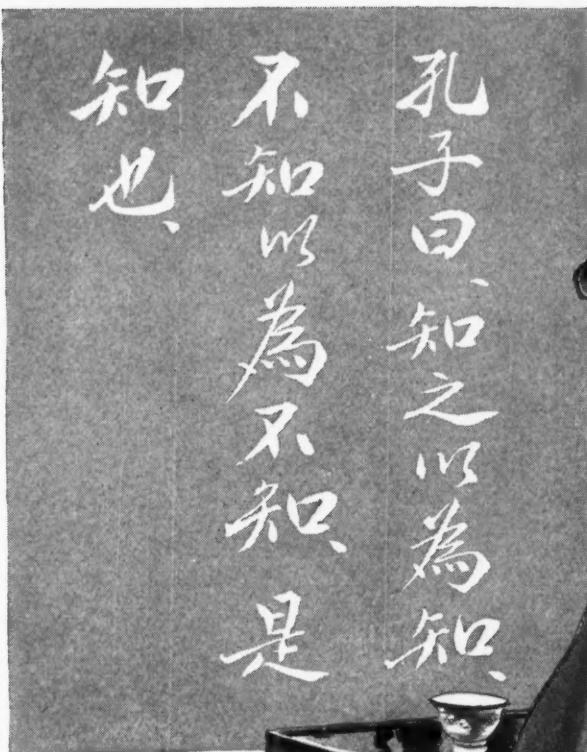
Tank radio operators are instructed not to try to get more range out of their transmitters than they are designed for: "Some radio operators after experience with the tank radio discover that by smart spot-picking (i.e., from a high hill) they can set up a long distance record of say umpty-five miles . . . Then there's hell to pay. The umpteen mile sets are suspected of the worst and promptly sent back to Maintenance for an injection of something or other . . . Don't let the rumor that so-and-so's set will do a regular umpty-five miles fool you. Someone is shooting what is known in polite circles as 'the bull'."

Tank radio operators are cautioned to familiarize themselves with their equipment and learn how to use it properly: "There's one thing about this radio business that sort of gripes the old timers. Nobody expects to start shooting a 75, a 37, a machine gun, or even a pistol until he's been taught a lot. But when it comes to a radio set—that's different, and any healthy American over 18 (and not dead drunk) is, for some reason or other, supposed to be able to walk up to the near side of a radio set, look it squarely in the eye, rapidly twist all the knobs in a different direction, stick a couple of plugs inside, and presto—have it talking both ways. But the above is pretty near 100 per cent baloney, and don't let it fool you."

Operators of mobile radio stations are cautioned against exposure to death-dealing high voltages, and are taught the use of safety devices. The Signal Corps pamphlet whimsically observes that "broadcasters need these devices to keep half-canned announcers and over-fed sopranos from sitting on their tank-coils."

In order to keep extraneous noises out of the microphone, operators are told to speak directly into the instrument, and not to "sit comfortably back like a sports announcer and proceed to talk a foot from your mike. Your signals at the other end will sound like four skeletons on a tin roof around the first of June."

Sometimes, when a mobile radio unit
[Continued on page 10]



Translation: — "When you know a thing, to hold that you know it; and when you do not know a thing, to allow that you do not know it; this is knowledge." —Confucius



"This is Knowledge" said the Sage . . .

Through the ages, the most learned have always been the most aware of their limitations.

Why is milk white? . . . Scientists admit that they do not know. They say, as did the late great Thomas Edison, that the total of man's knowledge is pitifully small.

In the vast field of Electronics, IRC certainly does not profess total knowledge. But in one small part of that field—the construction and application of Fixed and Variable Resistors—we do know many of the answers.

Because of our specialized research, we have succeeded in developing a line of resistance devices "Preferred for Performance" throughout the Electronic industries. Today IRC Resistors are so vitally essential for war equipment that we must concentrate our production efforts on caring for the needs of the Armed Services.

Though we may not be able right now to supply you with the Resistors you need for other than war uses, our Engineers and Executives are at your service for counsel, without obligation, to

help you in the solution of Resistor problems. Please feel free to consult them in your search for the best obtainable resistance devices under existing conditions.

You will find a source of complete Resistor information here.



FIXED & VARIABLE RESISTORS

Preferred for Performance

INTERNATIONAL

RESISTANCE COMPANY

411 NORTH BROAD ST., PHILADELPHIA, PA.

RADIO

* JANUARY, 1943

ARMY **E** **NAVY**

"FROM that high resolve was born the Army-Navy Production Award which stands today as our fighting forces' joint recognition of exceptional performance on the production front . . . of the determined persevering, unbeatable spirit which can be satisfied only by achieving today what yesterday seemed impossible!"

We're sincerely proud of our award - its significance will always be our goal.

TYPE 85
BLILEY
FREQUENCY CONTROL
SERIAL NUMBER
R19655
FREQUENCY
7115 KC
MADE IN U.S.A.
ERIE, PA.

BLILEY ELECTRIC COMPANY · · · ERIE, PA.

Bliley Crystals

TECHNICANA

is on the move, areas of radio interference, noise, static, and atmospherics are encountered that make it extremely difficult for an operator to hear radio signals over the bedlam in his receiver. Realizing radio's limitations, the Signal Corps admits that all an operator can do then is to "do your damndest to pick signals out of the hash."

That's language Americans understand.

★

MICROCOSMIC

★ Particles as small as one millionth of an inch—one thousandth of the diameter of a human hair—can be measured accurately with a new electron microscope developed by General Electric engineers. This was revealed by Dr. C. H. Bachman, of the G-E Electronics Laboratory at Schenectady, N. Y., in a talk December 1 to the Lynn, Mass., section of the American Institute of Electrical Engineers.

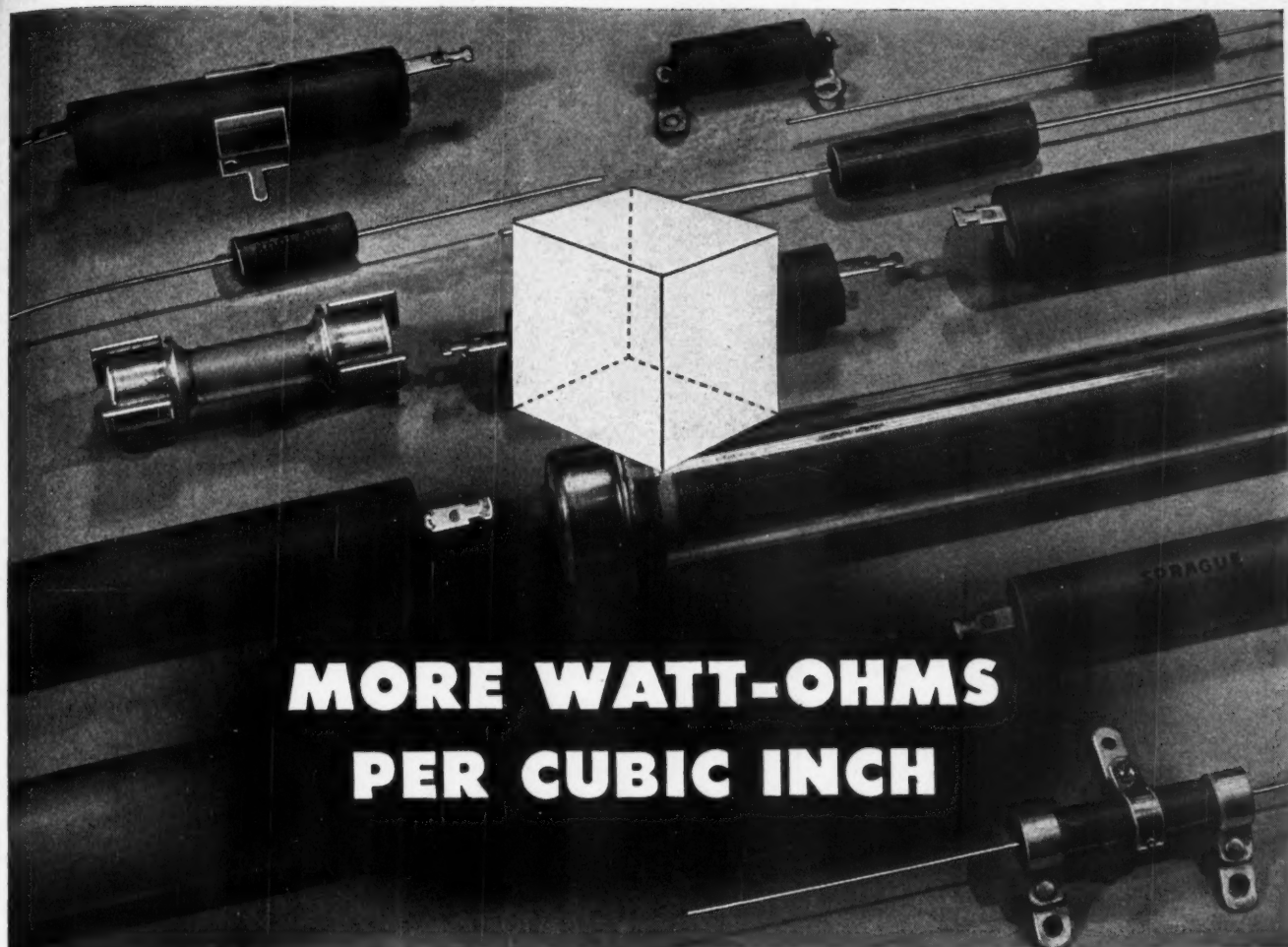
This is made possible by the use of a new type electron optical system which maintains a "fixed" magnification regardless of voltage variations; previous electron microscopes have suffered in this respect because their magnification varied with the applied voltage.

With the new G-E electron microscope, small cubical shaped smoke particles only one millionth of an inch, for example, can be clearly seen.

In the new instrument, a specimen can be enlarged 10,000 times. Further enlargement of the picture can be made photographically, up to 100,000 times the size of the original specimen, or better. Thus the total enlargement employed depends on how the resulting picture is to be used. If, for example, a picture is to be shown to an audience a larger print is necessary than would be employed in a book. What counts is the resolution, or sharpness, of the picture. The magnification is only a matter of choice or convenience.

"The measure of a microscope," Dr. Bachman explained, "lies in how small an object can be seen, rather than how much an image can be magnified, for magnification alone does not make a picture clearer."

If a human hair, about 1/100 of an inch across, were split lengthwise into 100 slivers, and 99 of these pieces were thrown away and the one remaining piece was split again into 100 similar pieces, each of these filaments only 1/1,000,000 of an inch across would stand out clearly in the G-E electron microscope.



MORE WATT-OHMS PER CUBIC INCH

...greater dependability...easier mounting...less weight

Yes, Mr. Engineer, this is an odd, non-standard technical term—but it is one easily understandable, and certainly one that best explains the tremendous advantages obtained with Koolohm Resistor construction.

... For Koolohms provide the highest wattage ratings and resistance values in a given volume, with safe resistance wire sizes.

... Moreover, Koolohms deliver their full wattage ratings regardless of resistance values.

... Koolohms can be mounted easier and quicker and in less space—directly to the chassis or to grounded parts.

... Koolohms give a big, extra measure of depend-

ability on the high resistance values by using larger wire ($2\frac{1}{4}$ times the cross-sectional area of that used by other manufacturers for these same values).

Koolohms are made with wire that is insulated before it is wound. This insulation is a special ceramic material having a dielectric strength of 350 volts per mil. at 400°C . It is heat-proof to 1000°C ; fully moisture-proof, and so flexible it can be wound on small forms, either in short-proof layer-windings, or in high-density progressively-wound interleaved patterns.

Write today for the complete Sprague Koolohm Catalog and sample resistors.

SPRAGUE SPECIALTIES COMPANY
(Resistor Division) North Adams, Mass.



Here is an actual comparison between a Sprague Koolohm resistor and a conventional wirewound!

Conventional	Specifications	Koolohm
2.5 mil. minimum	Limiting Wire Size	2.5 mil. minimum
10 watts, 7500 ohms	Rating	10 watts, 7500 ohms
$4\frac{1}{2}''$	Length	$1\frac{1}{2}''$
$\frac{11}{16}''$	Diameter	$\frac{7}{16}''$
40 grams	Weight	14 grams
Must not come in contact with chassis or grounded parts	Mounting (see above illustration)	Can be mounted flat on chassis or to grounded parts

SPRAGUE
KOOLOHM
WIRE-WOUND RESISTORS



A Wire Wound Resistor Isn't Modern UNLESS It's Wound with CERAMIC INSULATED WIRE!

The Voice of the Flat Tops!

... require unfailing performance! Jensen speech reproducers provide the authoritative Voice of the Flat Tops with unerring accuracy and dependability.

Jensen
 RADIO MANUFACTURING CO., 6601 S. LARAMIE AVENUE, CHICAGO

RADIO

JANUARY, 1943

EDITORIAL

MR. IBID. GOES TO WAR

★ Technological Synergism—which, resolved into simpler words, means “Cooperative Industrial Science”—has become a vital factor in the national war effort. Its finest expression is probably found in the ranks of the National Defense Research Council, where history is being made in no uncertain terms; but raw necessity has brought it to life in the automotive and aviation industries, to name but two production groups.

Technological Synergism is being applied in two ways; first, through the free interchange of ideas and trade secrets, and, second, through the direct swapping of raw materials and finished parts, by way of centralized pools. Both factors are means of getting things done faster and better.

The synergetic mind of the aviation industry, for instance, is so well-developed that normally competitive organizations in this field have no secrets left with which to trade on in the post-war period. Everything has been put into one pot, with the result that we have the interesting picture of an industrial entity operating almost on a socialistic basis.

This, of course, is a good thing so long as the war lasts; and there is no time for one to have qualms over what may happen thereafter; but a projection of the thought would suggest that the present synergetic process will not endanger the future position of any industry or organization, and may even bring about fresh ideas relating to the aspects of free enterprise.

As a by-product of synergism, we find the release of industry's stockpile of ideas and patents for the furtherance of the war effort, to the extent that there no longer exists a normal backlog of improvements upon which future plans can be projected. However, coincident with this complete exhaustion of engineering improvements in industry's “bank,” there arises a new generation of ideas and patents born of the war effort itself. And by this steady process of regeneration in ideas and ways of doing things, industry's original

stockpile just as steadily becomes obsolete, and as steadily replaced. Thus, from the principle of a war device may come a major improvement in, say, television; and who can say, then, that *anything* has been lost to the wartime principle of synergism?

There is probably no occasion for the radio industry to go to the extremes that the aviation industry has, for the sake of getting things done on time; after all, the production problems are altogether different. But, from the viewpoint of pure engineering, it would seem that a great deal more could be accomplished by the radio industry if the principle of synergism were embraced. One cannot escape the impression at times that our industry, as patriotic as it is, operates on the basis that technological isolationism is a good thing. And if we are not wrong, and some do feel that it is a good thing, then the question naturally arises: Good for whom?

In these times, hoarding ideas or ways of doing things is about as silly as hoarding butter—neither will keep. On the other hand, both ideas and butter can aid the war effort if they are put into circulation.

PATENTS

★ The Utopians don't like our patent system. It presumably stinks. Well, it does, in some ways, as so many things do.

Patents, of course, are two-faced; they protect the inventor and at the same time make him a monopolist. Which puts the inventor in the position of being a stinking benefactor.

All the Utopians have to do is to work things out so that an individual or a corporation gains the protection a patent affords, but at the same time prevents the patent rights from constituting a monopoly, which is quite simple—or is it?

The trouble is, if you cut off a dog's head to prevent him from biting, the tail stops wagging.—M. L. M.



Specializing in Sensitivity

● It takes the delicate touch of manicured hands, the keenness of 20-20 vision, for final inspection of fine mica parts. This specialized sensitivity maintains the high quality of Sylvania Radio Tubes.

When war made access to high-grade Indian mica difficult, Sylvania engineers were ready to meet the emergency with new processing methods. There was no interruption in the flow of up-to-standard mica parts.

This is one of many examples of quality

production control at Sylvania whose *one* job is the production of radio and electronic tubes.

This concentration prepared Sylvania engineers for the job of coping with war-time material problems.

Sylvania specialization in electronics is your guarantee of high-quality radio tubes, now as in the past. Your Sylvania franchise, which always has offered a clean profitable

deal, is a valuable business asset in these days when replacements make up the bulk of your business.

RADIO TUBE DIVISION

SYLVANIA

ELECTRIC PRODUCTS INC.

EMPORIUM, PA.

Incandescent Lamps, Fluorescent Lamps, Fixtures and Accessories, Radio Tubes, Electronic Devices



FM EMERGENCY EQUIPMENT

D. LEE CHESNUT

General Electric Co.

★ It is safe to say that no single development in the police radio field, or in the associated emergency communication uses, has met with such rapid wide public acceptance as has frequency modulation. Today, approximately two and one-half years after the initial commercial installation, "FM" as a communication tool is more widely accepted than was the idea of police radio itself in the same period of time after its initial introduction.

The foregoing facts are attested to by at least three conditions which are evident to those closely associated with

the industry today; first, an actual study of current production records of AM and FM equipment; second, the relatively small amount of customer-contact time that is consumed in "selling" the idea of FM; and third, the actual ratio of FM to AM emergency communication radio equipment authorized for the "Radio Reserve Pool" recently established by the War Production Board.

This article will therefore deal, not with why FM should be chosen for the majority of emergency communication services, but rather with what two and

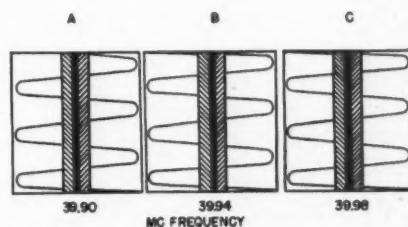


Fig. 1. The three emergency service carrier channels, spaced 40 kc apart.

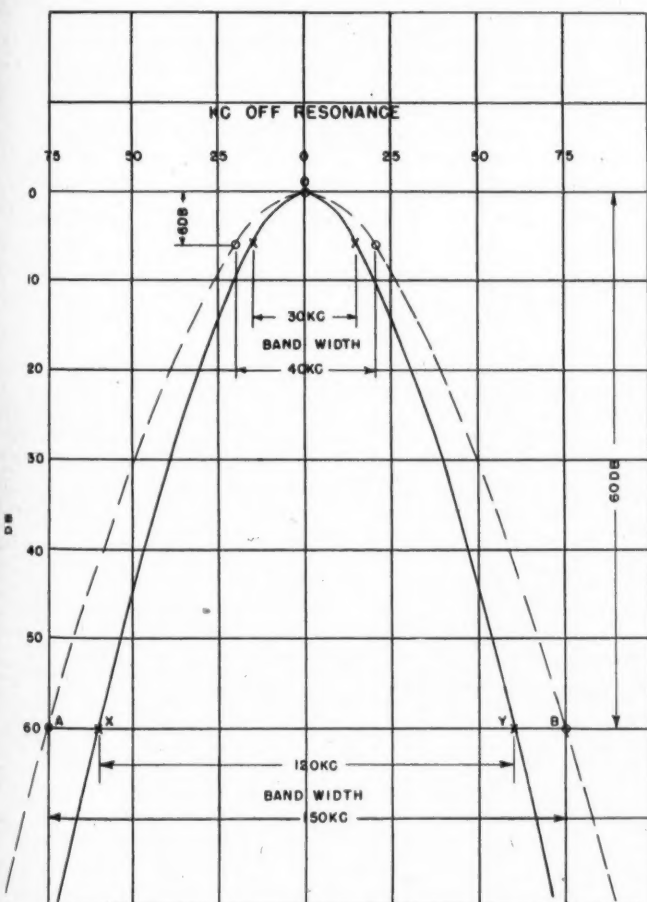


Fig. 2. Comparative selectivity curves of early and late model frequency-modulation receivers.

one-half years of actual progress has accomplished in the way of making a better communication tool available. This progress will be presented, not as a detailed technological change in circuits, components, accessories, etc., but rather will be keyed to the relatively few basic functions which a communication system is expected to accomplish. These are:

1—We want intelligible two-way communication over the greatest possible radial distance.

2—Within that distance, we want 100% coverage; that is, no "dead spots."

3—We want to achieve the lowest possible nerve-strain for the operator of the equipment, for whom two-way radio is simply a tool by which he can increase his effectiveness several-fold.

4—We want the equipment to withstand continuous normal use, plus the occasional severe punishment inevitable in mobile service.

5—We want to provide those features which make the equipment easily installed and easily serviced, so that all the foregoing functions may be continuously maintained.

I—Extended Communication Range

The major development in extending the range of FM emergency communication equipment, has, of course, been in the receiver. Given a certain amount

of antenna radiated power, a carrier with a frequency tolerance that meets the Federal Communications Commission specification of plus and minus 0.01%, and given transmitter carrier modulation free from "hash" and hum and distortion, the quantitative value of signal strength at any receiver location is a function of natural physical laws. These natural laws, to be sure, are not as definite as those governing the distribution of electrical energy over metallic circuits, but the conception of the problem will be clarified if we think of it as a problem in distribution where a given signal voltage is available adjacent to the antenna, reducing in inverse geometric ratio to substantially zero-voltage signal level at some point beyond the service range.

Now we quote the actual statement from our earlier receiver specification and show, in comparison, the current specification.

Earlier: "The receiver limiter tube is substantially saturated when the signal input reaches 1 microvolt."

Current: "20-db noise quieting will occur at a signal input of not more than 0.4 microvolt."

We have here a dual improvement; the first, actual increased sensitivity, since the 0.4-microvolt signal strength used to define the new sensitivity represents what might be called "substantial limiter saturation." Both designs, of course, have a margin of safety beyond the specification value. For example, the earlier unit could work successfully on received signal strength of the order of 0.5 microvolt, and the current design similarly on received signal strength of 0.1 microvolt. This increase in receiver sensitivity can

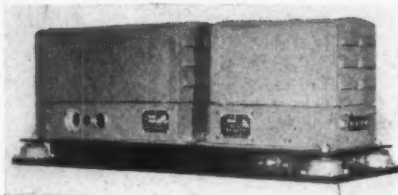


Fig. 4. Special shock mounting and vibration-damping base, for application to locomotives.

readily account for extensions in communication range of from 10% to 35% under varying conditions of interference static level. An absolute specific statement cannot be made without fully classifying the type of static interference. It is well known that static, which is amplitude modulated in nature, is over-ridden with the FM signal when the limiter circuit is fully saturated. However, static which is frequency modulated in nature is not rejected by limiter action, but is nullified in proportion to the amount of carrier swing, rather than by the degree of limiter saturation. Herein lies the inherent value of the Armstrong method of frequency modulation, which includes both the principle of the "limiter" and of wide-band modulation. This has been the subject of much discussion in the industry, but has now been thoroughly substantiated by actual experience.

It will be evident that the foregoing comparison of receiver specifications typifies not only an improvement in receiver sensitivity but also represents a clarification of the actual method of statement itself. Both are important from the standpoint of industry-consumer good-will. We substitute now

the definite quantitative statement of "20-db noise quieting will occur at a signal input of not more than 0.4 microvolt" for the previous rather general statement that "the receiver limiter tube is substantially saturated when the signal input reaches one microvolt." Both receivers are basically double-conversion superheterodyne units. The earlier receiver accomplished limiting with a single limiter tube. The new receiver employs two limiter tubes providing cascade limiting.

II—Reliable Communication

The more important basic elements of this problem are taken care of by the same design improvements covered by Section I. An additional "enemy" of reliable communication is the possible presence of interfering signals from other similar communication systems. Certain proclivities of the "squench" circuit might also be likened to "Fifth Column" activities from within, as being particularly destructive of uniform coverage.

It is well known, of course, that the FM receiver has remarkable ability to discriminate against the weaker of two signals on the same frequency, by the limiter action of the receiver. For best all-round performance, however, it is desirable to take advantage of every possible circuit improvement.

We refer you now to Figs. 1 and 2, in order to discuss the problem of receiver "acceptance bandwidth" which is a contributing factor toward eliminating interference from other signals as well as cutting down the amount of static that has to be over-ridden.

Fig. 1 represents three FM "Emergency Service" carriers A, B and C, as established by the Federal Communications Commission, spaced 40 kc apart. The three heavy lines represent the theoretical carrier frequencies of 39.90, 39.94 and 39.98 mc respectively. The shaded portions to the right and left of each carrier represent the limits of the carrier variation in accordance with FCC requirements of $\pm 0.01\%$ frequency stability. Now we illustrate by typical modulation waves a modulation of ± 15 kc required in this service, imposed upon the \pm limits of each of these carriers. Thus, adjacent channel frequency overlap is prevented.

It is obvious that the perfect receiver would have an "acceptance bandwidth" exactly equal to the theoretical transmitted signal shown, 30 kc wide at all levels of incoming signal strength. It would probably be possible to approach this in a laboratory model of a receiver designed to receive signals of a very narrow range of signal strength. But we have here the problem, first, of re-

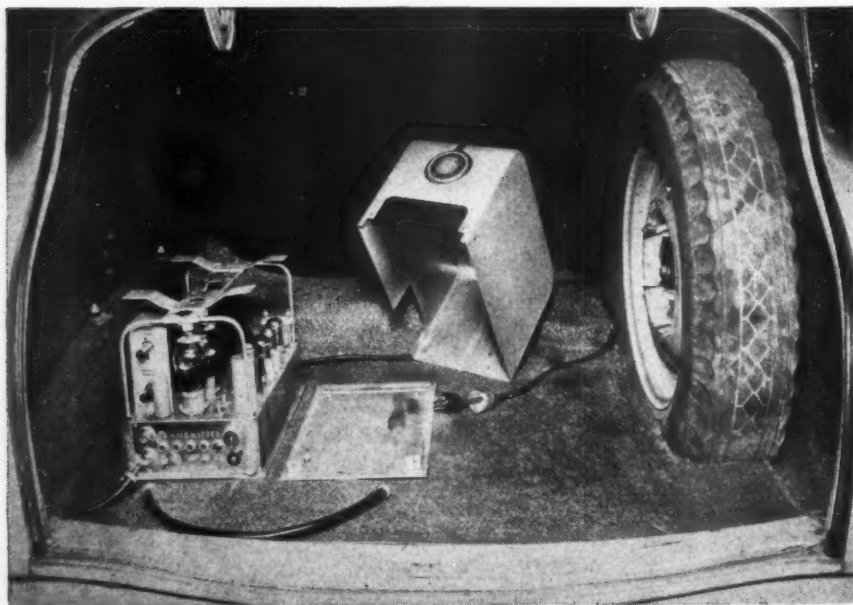


Fig. 3. Maximum life of equipment is obtained by bolting transmitter and receiver sub-bases to trunk compartment.

ceiving signals of perhaps 10,000 microvolts up close to the antenna—occasionally even much stronger signals—and as low as 0.1 microvolt out at the limits of communication range. We must, of course, also build a receiver that can be reproduced by quantity production methods at a price that will warrant its use by the intended users.

Fig. 2 now illustrates the receiver condition. The apex of the diagram

ceiver in position to accept the desired message, or keeping the receiver muted because of high prevailing noise level and low signal strength. Early FM receivers were not perfect in this regard. There were tendencies under some conditions to allow intermittent reception and blanking of reception, commonly referred to as "clipping." It may be safely said that the new design removes this obstacle to reliable communication coverage.

vice prevents audio output from the receiver except when a carrier is present on the frequency to which the receiver is tuned."

Present Unit: "With no carrier on, the receiver will remain muted on all random noise. The squelch circuit automatically opens the receiver on a signal input as low as 0.1 microvolt, if desired, adjustable up to 0.4 microvolt."

Again dual progress is indicated. While the earlier specification did not state a quantitative value at which the desired signal would open the squelch circuit, this would actually happen at a signal strength of about one-half microvolt. The current design now reduces this to 0.1 microvolt, which is practically the threshold of audible reception. The earlier design provided only an on-off switch for the squelch—it was either in operation, or it was inoperative. We now provide a squelch adjustment on the control unit for both fixed station and mobile type units. The level of interfering static is by no means a fixed quantity for either station or mobile service, obviously much more variable for mobile units. The operator may now, therefore, provide for maximum sensitivity of his receiver, and yet keep it silent and thus greatly reduce the day in and day out nerve strain, because of the remote adjustment feature. We have purposely set the upper limit of this squelch adjustment at 0.4 microvolt, since this point corresponds with the point of substantial noise-quieting and should therefore provide for good signal reception.

IV—On-the-Job Reliability

We have approached the problem of "shock mounting" without any preconceived idea. We were at first inclined to believe that shock mounting would definitely be required in order to protect this type of equipment from the effects of rough usage over the roads. Our early experimental installations were made with "shock mounting bases" and the first thing we learned

corresponds to a certain maximum desired signal strength and the height is proportional to signal strengths of decreasingly lower intensity. Two such signal strengths of 6 db and 60 db "down" from the established apex level are shown, since these are commonly used reference points approximating normal and low signal strengths dealt with in this service.

The area *OAB* represents the earlier design of receiver with 40 kc bandwidth at 6 db down and 150 kc bandwidth at 60 db down. The area *OXY* shows in comparison the acceptance bandwidth of the current design of receiver. The areas between the two represent possible interfering signals that earlier receivers would have accepted that the current design would reject. The reduction in load imposed upon the receiver is obvious.

The discussion of the "squelch" circuit in total logically belongs under the next section of this article. Under this heading of "Reliable Communication" within the service area, we would state here that the early squelch circuit did not completely solve this problem because of the newness of the problems presented. The type of squelch circuit used on AM receivers could not be used since they were sensitive to AM noise, and since the FM receivers would operate on such low signal strength. The objective should be that for any particular adjustment of the squelch circuit that it remain either open or closed; that is, leaving the re-

III—Minimum Nerve Strain

Just as Section II built upon Section I, so now we may say that the accomplishment of this third objective builds first upon the degree to which the problems discussed in Sections I and II are solved.

Under Section II we referred to that part of the squelch circuit design related to a possible "clipping" of messages. We refer here to the over-all squelch circuit performance. As in Section I, progress is indicated by definiteness of the statement of our respective receiver specification. We quote:

Earlier Unit: "The carrier-off noise suppression circuit is so designed that it discriminates against amplitude-modulated signals (such as random noise) and passes constant-amplitude, frequency-modulated signals. This de-

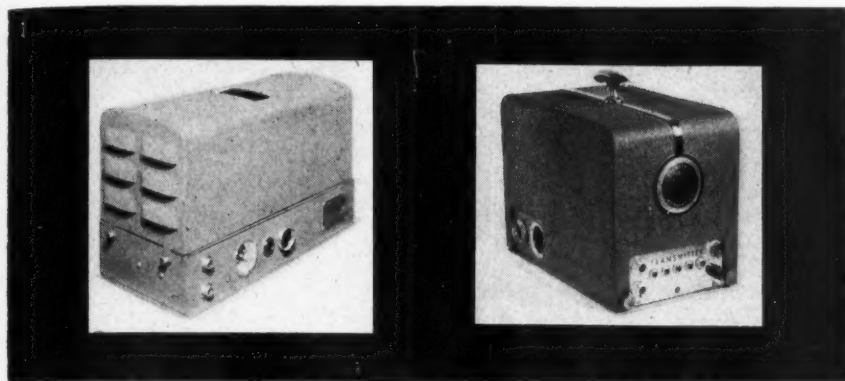


Fig. 5. Modern dust-proof unit (at right) as compared to the earlier unit with louvers. The new design is also more compact.

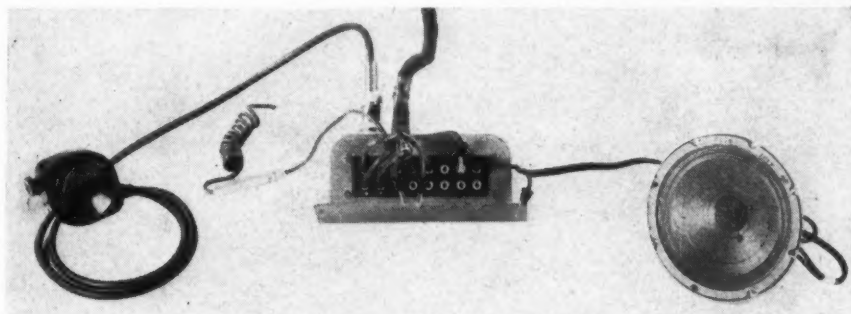


Fig. 6. Plug-in type of interconnection. This provides for easier testing, and smaller cable holes in car body.

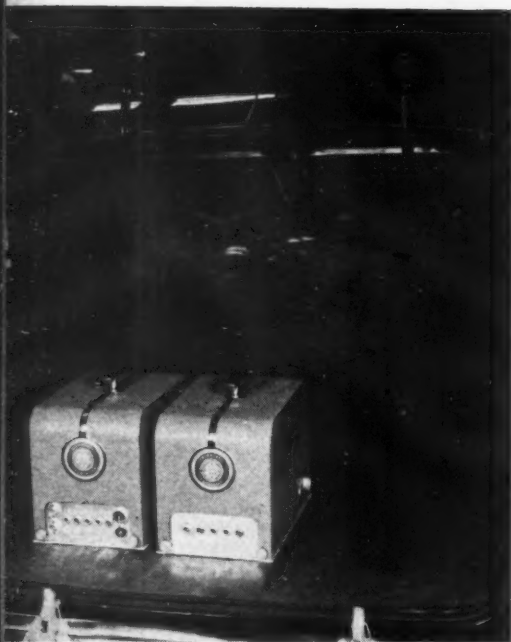


Fig. 7. Side-by-side mounting, and with largest dimension towards the rear, leaves usable prowl-car trunk space.

was that the problem actually divided itself into two distinct studies: one of "shock mounting," and the other of "vibration damping." Actually, the early attempts at shock mounting produced an effect which might be described by using the term "vibration amplifier." True, the mounting used to reduce the effect of sudden shock, such as a car dropping into a rut in the road, might slightly reduce such an effect, but under many circumstances the natural period of vibration of the equipment came into play, and what would have been a single shock blow of certain proportions became a sustained series of periodic vibrations that were more destructive to the equipment than the initial blow that we were trying to protect against.

This study was continued in both road vehicles and in elaborate laboratory shock and vibration testing equipment. We came to this definite conclusion that when this type of equipment is mounted in vehicles as used by police departments, the maximum life will be obtained by bolting the transmitter and receiver sub-bases solidly to the trunk compartment of the vehicle. Such a typical installation is indicated in Fig. 3.

The foregoing statements do not apply when this equipment is used for other services, such as mounting in Diesel-electric locomotives where shock or vibration mounting is not inherent in the vehicle itself. We refer you now to Fig. 4, which shows a specific design of this FM emergency communication equipment, mounted on a special

"shock mounting and vibration damping" base developed for the application of this equipment to Diesel-electric locomotives. The dual nature of the problem previously described is illustrated in the features included with this base. The flexible foot mountings at the corners of the base take care of the problems of shock mounting which is desirable for this service, where the locomotives are pounding over steel rails constantly; are subject to severe shocks when coupling to and uncoupling from cars; and where the locomotive spring suspension is such as to provide absolutely no shock mount in terms of the requirement of this class of equipment. Because of limited space in locomotives, the communication equipment is often mounted on a shelf affixed to the side of the locomotive cab which thus multiplies the vibration effects. We therefore include vibration damping features illustrated on both the side and the end of the base which are effective in reducing both lengthwise and sidewise vibrations. Such bases are fully justified for this class of service in terms of the longer life and less servicing required.

Any successful approach to this problem of two-way communication when one end of the circuit is in a mobile vehicle must take into account the power-supply limitations within the vehicle itself. To emphasize this problem, it is probably safe to say that in the normal life of any passenger automobile, used for normal personal or business service, more failures to start will be caused by battery trouble than by any other single factor. Again to emphasize the problem, we should not overlook the fact that the total battery drain required to support the emergency communication receiver, plus the stand-by or idling drain of the transmitter, is roughly two-thirds of the battery drain required for the combination of headlights plus tail light,

or is about double the requirement to operate the average car heater at maximum speed.

It is obviously short-sighted policy to accomplish the utmost in receiver sensitivity and selectivity and squelch performance if such a design results in a battery drain which would cause undue failures in the car power plant. Furthermore, such finely developed and sensitive characteristics are only maintained if the receiver is supplied with approximately normal voltage, and such gains may be more than offset by low voltage delivered by the car power plant if the battery drain is excessive.

Our initial receiver design was a deliberate choice based on the then-known factors affecting sensitivity and battery drain. Battery drain at that time with a dynamotor power supply on the receiver was approximately 8.0 amperes, and the sensitivity as explained heretofore provided for "substantial limiter saturation at 1 micro-volt signal input." It was well known then that sensitivity could be increased to a value approximating that of today's receiver, but to have done so at that stage of the development of the art would have increased the battery drain to approximately 11 amperes. Therefore, in the interest of well-balanced design and with complete respect for the limitations of the car power plant, we deliberately postponed the use of the greater receiver sensitivity until design knowledge had made improved over-all performance available at no increase in battery drain. As a matter of fact, the sum of the battery drain for our earlier designed equipment with dynamotor type power supplies for both transmitter and receivers was eight amperes for the receiver, plus three amperes idling drain for a 25-watt transmitter, a total of eleven amperes at six volts. The comparable figures for the current design are 7.5 amperes for a far more sensitive re-

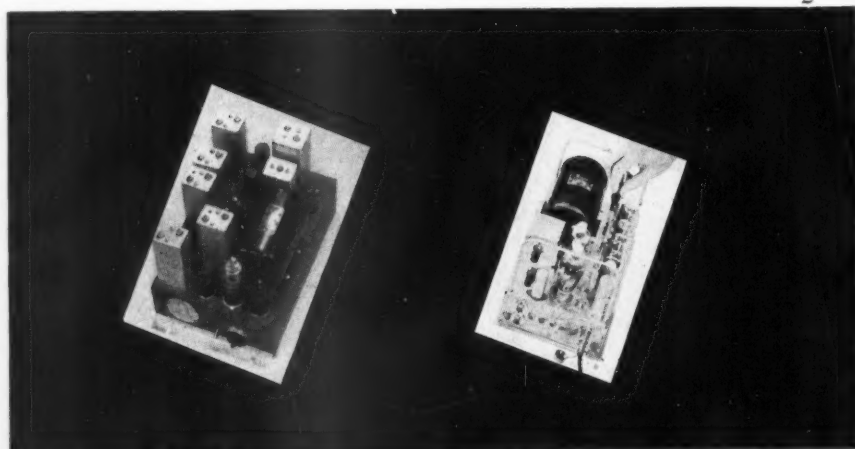


Fig. 8. The new unit, at right, with iron-core tuning, as compared with the earlier model with air condenser tuning. New unit is smaller and easier to align.

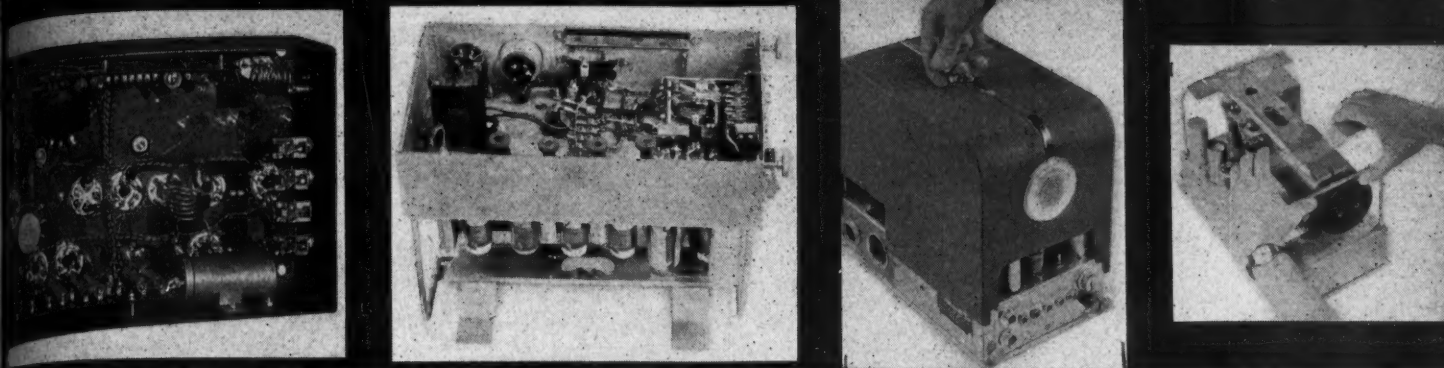


Fig. 10, A, B, C, and D, showing old and new designs. Workbench support in new units facilitates servicing.

ceiver plus 2.1 amperes for a 30-watt transmitter instead of the previous 25-watt unit, representing a total of 9.6 amperes, but with definite improvement in both transmitter and receiver. Then, because of the extreme importance of this question of battery drain, we added a mobile receiver with vibrator-type power supply as a standard unit of our line, with a reduction in receiver battery drain from 7.5 amperes to 5 amperes at six volts. The latter accomplishment has a further advantage in connection with sustained reliable communication and low maintenance expense because of the reduced load on the vibrator contacts.

Everyone knows that the trunk compartment of an automobile is not a place that can be noted for its cleanliness. Fig. 5 shows the evolution from the earlier design with ventilated louvers on each end, to the current model with solid unventilated enclosures. Since heat generated within the unit varies as the square of the current drawn, it will be seen here that low battery drain again has its effect in terms of lower temperature within the enclosures. The advantage of solid enclosures in terms of keeping road dust and dirt out of equipment is obvious.

V—Easily Installed and Serviced

The basic features that would be classified under this section and which were included in the earlier design have proven to be wisely chosen and therefore they have been continued into the current design. Such features include transmitters and receivers built on separate chassis, so that either one could be removed for servicing without disturbing the other. This results in a minimum of time for servicing a particular unit or a minimum amount of spare equipment on the shelf. It includes also the removable base plate construction as illustrated in Fig. 3. The base plate is bolted solidly to the trunk compartment and the chassis is held to this base plate by an angular

clamp on the back end, held in place by thumb screws on the front. It is not necessary to reach around behind the unit to remove the chassis with this construction.

In the mobile unit the control unit serves to interconnect the major parts of the equipment. Fig. 6 illustrates the construction which is now being used, showing that all connections are of the plug-in type. The multiple connections of the control cable terminate in individual plugs rather than in a multiple plug jack, so that this end of the control cable may be passed through holes drilled in the car chassis or body sections from the trunk compartment to the control unit, such holes thus being required of a diameter just large enough to pass the cable itself.

Another feature of convenience to the prowl car operator is illustrated in Fig. 7. Here we see a transmitter and receiver mounted side by side in a trunk compartment, the long dimension

of the unit pointing from front to back. This arrangement is made possible by locating the base plate thumb screws, the microphone jack and the test receptacles on the narrow end of the units. It will be seen that this leaves a relatively large amount of usable trunk compartment space to the right of the equipment.

Reference to Fig. 8 will reveal one complete departure from earlier designs that has resulted in easier alignment of the equipment both initially and during its life. The air-trimmer type of capacitor has been almost universally used for tuning adjustments in this class of service. The new design has adopted the inductive tuning method, commonly referred to as "iron core" tuning or "plug tuning." With this method the changes in circuit constants are accomplished by moving a soft powdered iron core vertically in and out of a small inductor or coil held

[Continued on page 55]

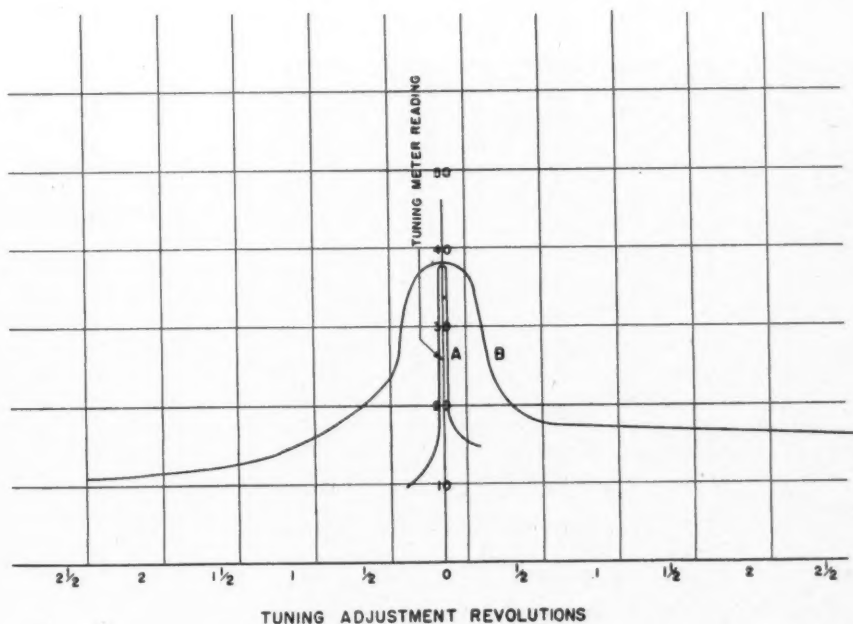


Fig. 9. Curves showing comparison between air-condenser and iron-core tuning. For one thing, the latter is less critical and not as subject to drift effects.



Navigation and communication in the air. (Official Photo, U. S. Army Air Forces).

ELEMENTS OF RADIO AVIGATION

L. LEKASHMAN

★ Navigation by radio for aircraft differs in many respects from surface-vessel procedure. By no means the smallest difference is the tremendous speed variance between air and surface ships. The speed of aircraft demands accuracy in order to prevent error, relatively unimportant at a ship's slow rate, since it is easily corrected

for, but which might take a plane hopelessly off its course.¹ There are different demands made by aerial navigation, some of the most exacting being requirements of successful war-time flying. The trip may be a trans-oceanic flight in which accuracy is a vital necessity because of fuel limitations; it may be a bombing mission, or

routine flying in which physical objects, restricted zones and scheduled stops are dependent upon a combination of good radio and celestial navigation.

The importance of radio navigation for airplanes cannot be over-emphasized, since celestial navigation is tremendously limited by day and because overcast may prevent the use of celestial navigation at the most inopportune times. In addition, the radio facilities make practical instrument approaches and blind landings, otherwise impossible.

Navigation by radio ranges, as in the case of domestic flying, will not be discussed as it is a branch of radio navigation largely divorced from navigation involving the use of a direction finder, or DF loop. With few exceptions, airplanes flying the range do not carry a separate radioman, and thus the science of radio range navigating falls into the realm of piloting. The fact that most commercial airlines flying ranges do not carry a radioman does not detract from the radioman's value. A number of fatal accidents in

¹The greater the speed, the less effect wind drift will have on a plane. At existing cruise rates for most commercial and military carriers drift assumes major proportions.

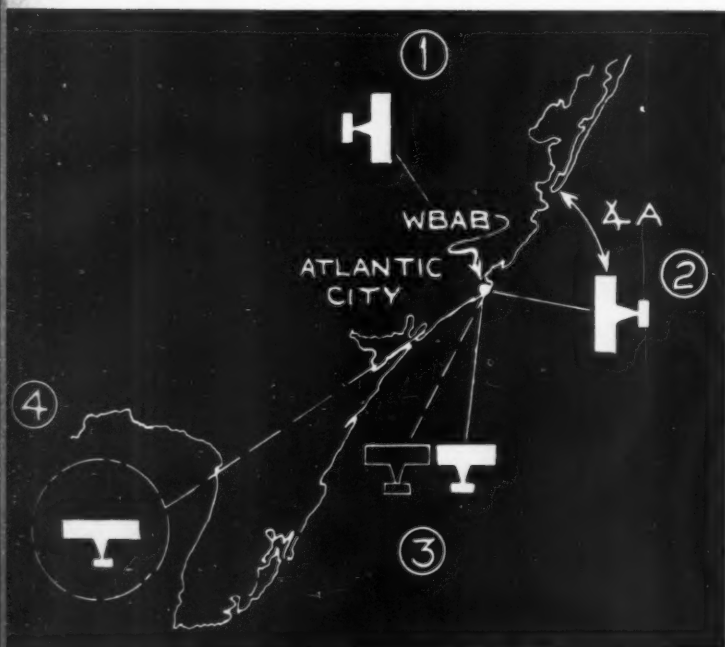


Fig. 1. To avoid coast-line effect angle A should be kept greater than 30°. (1) Bearing will have no coast-line effect, but may have some terrain error. (2) Ideal conditions for DF. (3) Coast-line error. White plane is indicated bearing, black plane is actual position. (4) Plane in bad position for DF. Circle indicates any number of false readings possible, due largely to terrain effect.

the United States were laid to shifting radio ranges caused either by electrical, natural, or mechanical failure. A competent radioman more than likely would have detected such shifting by continuous observations or supplementary bearings and prevented the accidents. The possibility that domestic airlines may some day carry radiomen to handle navigation and to offer the additional safety factor and conveniences of radio service to the passengers is not to be lightly considered.

Direction Finders

It is the purpose of this article to discuss navigation procedure and its problems, rather than the associated apparatus. A brief description of direction finder equipment (DF) may tend to clarify certain points discussed herein. Airplane equipment is bound to vary tremendously, depending upon the type of service, etc.

Installations consist of at least one receiver, but not necessarily designed for DF alone. Usually a receiver used in conjunction with an automatic direction finder (ADF) is of this unit-type design. A loop, consisting of an electrostatically shielded coil, in a suitably streamlined housing, and mounted somewhere on the plane's fuselage, is connected to the receiver. It is by means of this loop that the direction of the signal may be determined. A sense antenna may be employed in connection with the loop to make it uni-directional, otherwise the bearing read may be a reciprocal. Procedure to determine this is discussed later.

Almost invariably experience will tell the operator where his station lies in relationship to the plane, keeping in mind that a station ahead would give a relative reading of 0° , astern 180° , to the right 90° and to the left 270° . (Relative reading would be the actual loop reading with only loop error correction computed). In most ADF's there is some means of rotating the loop manually or independently of the automatic control, in the event of signals too weak to actuate the ADF, or mechanical failure.

Ground Installations

Ground installations are mainly one of two systems, the Bellini-Tosi system, or Adcock system. The Bellini-Tosi system employs open loops, permanently fixed in a triangular shape and oriented so the points lie north, east, south, and west. By the use of a goniometer, a pair of coils set at right angles to each other which have a small rotatable coil set in the middle, the direction of a signal may be obtained. The goniometer may be placed anywhere and is usually in the station it-

Station	WABC	WCAU	C MAY	WEEI
Time	1310	1400	1451	1500
Frequency	880	1210	370	590
SPLIT		50		30
MINIMUM		200		330
OBS. DF	40	225	270	345
CORTD DF	42	221	270	349
COMPASS	171	65	42	104
CORT. COMP.	174	64	43	105
MAG QTE	216	285	313	454
	-360	-360	-360	-360
MAG QTE	216	285	313	94
VARIATION	-10	-7	-8	-4
TRUE QTE	206	278	305	90
	∓ 180	∓ 180	∓ 180	∓ 180
RECIPROCAL	26	98	125	270
				DOUBTFUL

Fig. 2. Typical form carried on planes to record bearings. If sharp minimum is obtained it is not necessary to indicate split or minimum, as in the case of the bearing on WABC. Doubtful bearings are usually crossed out to avoid any mistakes. The QTE True is given to the navigator. Reciprocal is plotted by the radioman.

self, at the operating position. It operates on the principle that the induced e.m.f. in the pair of coils is proportional to the cosine of the angle of incidence and the resultant field is thus similar to the fixed loops. The rotating loop is tuned for a minimum aural null in the same manner as the conventional loop.

The Adcock system uses four vertical radiators connected to the goniometer through shielded lines. Its chief advantage lies in the fact that pick-up of horizontally-polarized signals is kept to a minimum, so that the resultant null is sharper and, above all, night effect is considerably reduced.

Bearings taken on other than a vertically-polarized signal are not good. For this reason care must be exercised in selecting stations for DF work. Low-frequency bearings in the 200- to 550-kc band are generally accepted as the most accurate, a fact easily explained by the weak sky waves. Marine beacons, radio range stations, and radio phares, whose specific purpose is to provide radio bearings, all transmit vertically-polarized waves and are ideal for DF work. Broadcast stations are widely used because their power is generally high, giving excellent range, and almost all of them use vertical

radiators. Bearings taken on a frequency above 1600-kc are usually supplied by special guard stations that will take a bearing (QTE) or transmit a signal for the plane to take bearings on (QTG) upon request. Bearings on frequencies above 1600-kc. are considerably more erratic and subject to various natural phenomena far more readily than low-frequency bearings. While their use is not discouraged, caution must be exercised, and under no circumstances should they replace low-frequency bearings if the latter are available.

Compensation of Errors

Errors in DF work may be classified in two groups; those introduced by human failings and those caused by natural phenomena. Since the man-made error may be readily determined and compensated for, it is relatively unimportant. Error introduced in the loop by shielding or electrostatic effect is compensated for with various balancing networks in the loop leads. In addition, the plane is "swung"; that is, by the use of a pelorus or other accurate angle-measuring instrument, the plane is lined up with a signal-generating device on a number of compass



Azimuth indicator of ADF type of radio range receiver. When station is tuned in, needle points a true bearing so that pilot can beam in. (Photo by Western Air Lines).

points. The radio compass or loop dial reading is observed and deviations from the pelorus are plotted on a correction curve. In most ADF's this compensation may be done in the receiver or compass and direct readings are thus available.

DF error introduced by natural phenomena is by far the most serious problem in accurate navigation by radio. Night effect; coast-line effect and directly related to the latter, terrain effect, are the commonly encountered causes of poor or inaccurate bearings. Terrain and coast-line effect may result in erratic bearings, but usually there is no aural indication that the bearing is other than normal. Terrain effect causes poor bearings because of physical obstructions, such as mountains, etc.

Bearings on stations behind obstructions should be avoided if a signal source over clear terrain is available. By visual angle measurement, error caused by nearby objects may be calibrated in the case of a ground DF taking bearings on a plane (See DF loop calibrating procedure.) It is generally not practical to transmit this error to a plane taking a bearing and it becomes a difficult task for the radioman to discriminate against good and bad bearings taken on a terrain effected station. The error that may be caused by physical obstructions can be of such a magnitude that the bearing will have little value. Because of the variable factors involved in taking bearings on stations behind obstructions some general knowledge of the signal source's general characteristics is definitely necessary. Often stations behind hills, etc., are not even effected whereas others have a consistent error which, if known, can be readily compensated

for. For homing, terrain error may cause a lengthened flight, but signals will lead to the station. When terrain-affected bearings are used off the tail, care must be taken that they do not lead the plane hopelessly off its course. Most charts used for both types of navigation, radio and celestial, will indicate, either by imprints or contour lines, elevation of all land surrounding a radio station. Terrain effect may also affect bearings taken on inland stations even though the signal path is over relatively level ground. Coast-line effect is due entirely to refraction of radio signals because of their proximity to the coast. It is least when the bearing is at right angles to the coast and greatest when the bearing is parallel, as outlined in Fig. 1. Necessity will dictate the stations to be used for DF, but in the event a choice exists, bearings of over 30° are preferable. If the bearings taken are entirely over land, no coast-line refraction will be introduced in the reading.

Fig. 3. Course plotted by radio bearings on theoretical patrol flight New York to Nassau. Chart normally used would include latitude and longitude lines; magnetic variation lines; and mercator corrections if chart was mercator type.

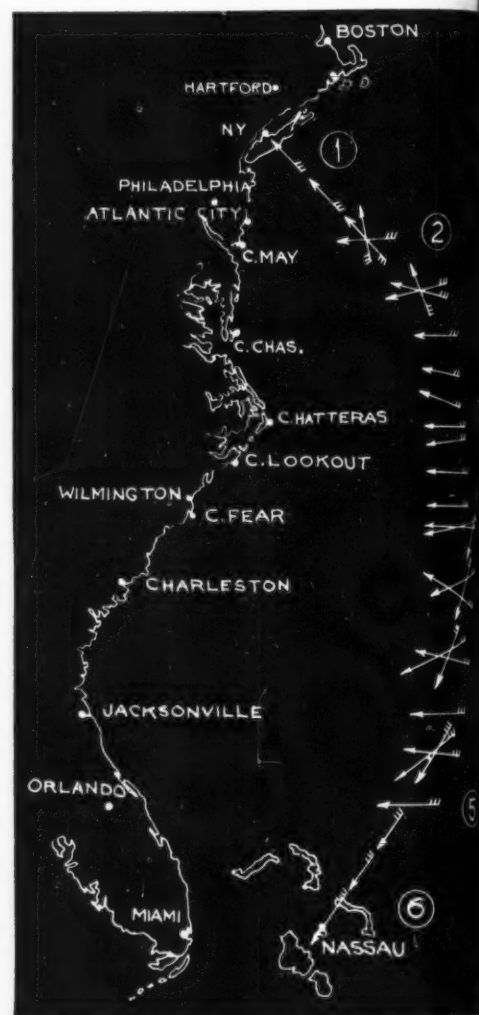
(1) Track bearings off tail. (2) Three station fixes. Unusually good because of excellent relationship of plane's position to stations. (3) "Abeam" and speed check bearings. Used here without track bearings because no source is available. (4) Three station fixes showing normal error which is gradually reduced as plane gets closer to stations. (5) Combination of "Fix", track and abeam bearings showing number of ways position can be checked. (6) Track bearings off nose with ship finally homing in.

Night Effect

Night effect is extremely serious in DF work and is generally experienced at any hour from two hours before sunset to two hours after sunrise. The presence of a strong downward-traveling horizontally-polarized wave induces an e.m.f. in the loop other than the vertical component of the signal. As a result the null or minimum signal of the loop will not occur when it is perpendicular to the signal. In theory, a signal with no vertical component will introduce an error of 90° in the loop. Night effect will often cause an indistinguishable null, but more serious even than that, it will result in a false minimum. A null may be obtained which will soon start to shift. The minimum may creep back and forth or even jump over a considerable portion of the loop scale.

It is this complete undependability which calls for the utmost caution during hours when the sky wave has a tendency to be stronger than the ground wave. As previously mentioned, and emphatically repeated, it is because of night effect that the low-frequencies are better for DF, since their

[Continued on page 50]



Thermal Radio

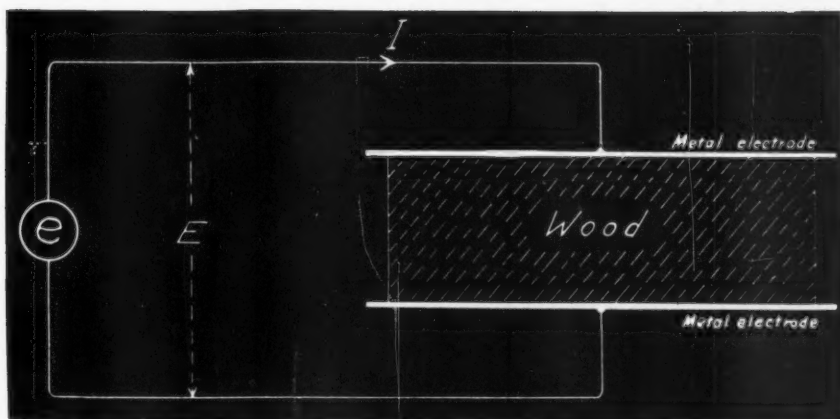


Fig. 1. Fundamental circuit used in heating wood with radio-frequency power. The wood is placed between metal electrodes which are connected to a generator (e). Resistance to passage of the current I causes the wood to heat.

HEATING WOOD WITH R-F POWER

JOHN P. TAYLOR*

★ Radio-frequency power has been used to overcome what seemed an insurmountable problem in the production of airplane propellers made of compregnated wood. Radio frequency is being used to expand the production of laminated and box spars, truss-type rib constructions, bomber floors, bomb bay doors and other aircraft parts. It is being tested for use in making various molded plywood forms such as wing elements and fuselages. Experimentally it is being used for seasoning wood, drying aircraft-quality plywood and curing various types of impregnating resins. In all of these applications the desired effect is obtained as a result of the heating developed in the wood by the use of radio-frequency power.

Obviously these applications are important—and this lends importance to the questions which naturally arise: How is radio-frequency power applied? What makes the wood heat? Why is radio-frequency current used? What advantages does the process offer? What limitations does it have? How do results compare with those of other methods?

Actually the method is too new to

*RCA Manufacturing Company, Inc., Camden, New Jersey.

†Abstracted from a paper presented at the Annual Fall Meeting, Rochester, New York, October 12-13, 1942, of the American Society of Mechanical Engineers.

give final answers to all of these questions; however, enough work has been done to make it worthwhile to review the information which is available.

Application of Power

Heating wood with electric power is (aside from the strictly application problems which arise) a relatively simple operation. Theoretically, at least, it is only necessary to have a generator of suitable characteristics and to connect the same by means of wires or other conductors to the wood which it is desired to heat.

Such an arrangement is illustrated by Fig. 1. A generator (e) is connected to two metal electrodes. The wood which it is desired to heat is placed between these plates. The reason for the plates can be understood by inspection of Fig. 2. In this illustration the dotted lines represent current paths and the number of lines in any particular part of the wood block is an indication of the current density in that section.

If connections to the wood are made at single points, or by means of small contact plates, the current distribution will be approximately as shown in Fig. 2 (a). In this case the corners of the block, since there is less current through them, will be heated very little—and the parts of the block which are close to the contacts will be overheated. In some cases such a distribution might

be desirable, but ordinarily a more even distribution of heating is desired and this can most easily be obtained by using large electrodes as in Fig. 2 (b). With such an arrangement the voltage generated at (e) causes a current I to flow around the circuit, through the wood and back to the generator as shown. The magnitude of this current will be determined by the voltage available from the generator and the resistance presented by the wood.

Heating Process

In the case of the poorer conductors, such as wood, the resistance to the

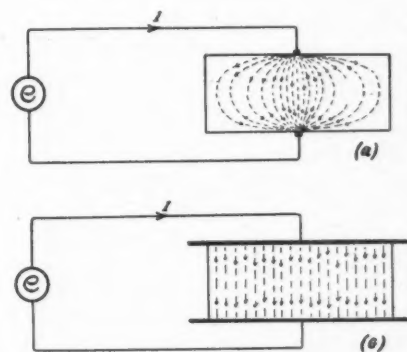


Fig. 2. The distribution of current paths through the wood (a) when only small contact points are used; (b) when large metal plates, called "electrodes" are used.

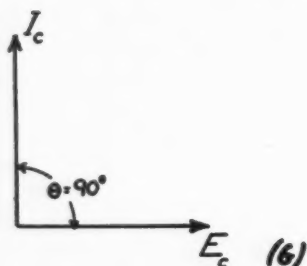
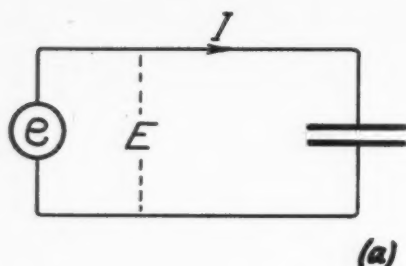


Fig. 3. Schematic (a) and vector (b) diagrams for a circuit in which a generator is connected to a "perfect" condenser. The current and voltage are 90° out of phase; hence, no power is consumed.

passage of direct or low-frequency current is very high. The voltage which would be required to cause an appreciable 60-cycle current to pass through these poor conductors would be out of practical reach (of the order of millions of volts). However, as the frequency of the current is increased the equivalent resistance of these materials drops almost inversely. At frequencies in the range of what we normally call radio frequencies it becomes low enough that it is practical to force through these poor conductors enough current to heat them as we desire.

Although some writers on the subject have taken the opposite view, there is no essential difference between high-frequency heating and low-frequency heating. For a purely practical reason—viz. that the required voltages are lower—it is preferable to use radio frequency for the heating of poor conductors. The mechanism of heating is exactly the same.

Physicists picture the heating which occurs as being due to "molecular friction" caused by the passage of current through the materials. They visualize this current not as a stream of electrons each of which flows all the way across the material, but rather as the net effect of the motion of all the electrons. Normally these electrons have random orbits. When a voltage is impressed across a section those electrons which are not too tightly bound change their paths somewhat so as to produce an overall effect of a charge moving from one side to the other. This displacement of the paths of the electrons represents work done and this work appears as heat.

The difference between good conductors and poor conductors is represented by the degree of freedom of the so-called "orbit electrons." There is no fundamental difference in the heating effect. In either case it is due purely to the "conduction loss" which occurs due to actual passage of current through the material.

Effect of Frequency

Where the dimensions of the "package" of wood to be heated are known it is relatively easy to calculate the voltage which will be required to obtain a certain heating effect. Electrically the metal electrodes between which the wood is placed form a condenser. If these electrodes were separated by air they would form a so-called "perfect condenser." Such a condenser would be represented schematically as in Fig. 3 (a), and the voltage across and the current through this condenser by the vectors of Fig. 3 (b). In this case the voltage and current are 90 degrees out of phase and the average power dissipated in the condenser is zero.

When, however, the wood is placed between the electrodes, we no longer have a perfect condenser since the wood presents a leakage or "conduc-

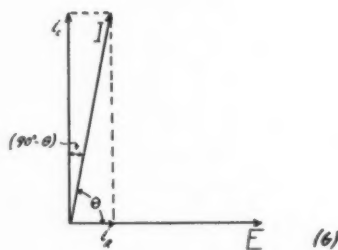
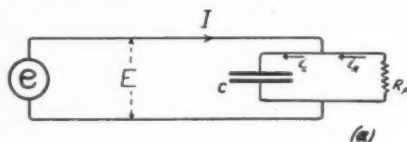


Fig. 4. Schematic (a) and vector (b) diagrams for a similar circuit in which the condenser has a poor dielectric such as wood. The current i_R flowing through the equivalent resistance R_p represents the power expended in heating the wood.

tion" path. The imperfect condenser thus formed can be represented schematically by a perfect condenser paralleled by a resistance R_p as shown in Fig. 4 (a). The capacity of C is the same as the capacity of the imperfect condenser, and hence is a constant. R_p , however, is purely an "equivalent" resistance and is not independent of frequency. It is, therefore, necessary to calculate R after the frequency of operation has been chosen.

The relations of voltage, current, power and frequency of the circuit shown in Fig. 4 (a) can be obtained directly. Fig. 4 (b) is the vector diagram. In this case the total current I leads the voltage across the load by something less than 90 degrees. The total current I is made up of two components, viz., the capacity or "out-of-phase" current i_c and the resistive or "in-phase" current i_R . Since the first does not represent any power furnished to load, we are not interested in it, but only in i_R and the resistance R_p through which it flows. In order to calculate R_p we note that:

Power factor = $\cos \theta = \sin (90^\circ - \theta)$
for small angles
 $\sin (90^\circ - \theta) \cong \tan (90^\circ - \theta)$
Hence:

$$P.F. \cong \tan (90^\circ - \theta) \cong \frac{i_R}{i_c}$$

$$i_R = \frac{E}{R_p} \quad i_c = \frac{E}{X_c}$$

$$P.F. = \frac{X_c}{R_p}$$

$$R_p = \frac{X_c}{P.F.} \quad (1)$$

The value of X_c can be calculated from:

$$X_c = \frac{1}{2\pi f C} \quad (2)$$

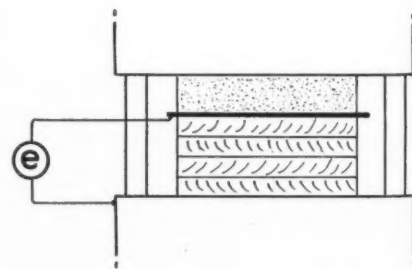
where: C (in farads) = $\frac{KA}{4\pi d}$

K = dielectric constant;
 A = area of plates in cm^2 ;
 d = separation of plates in cm.

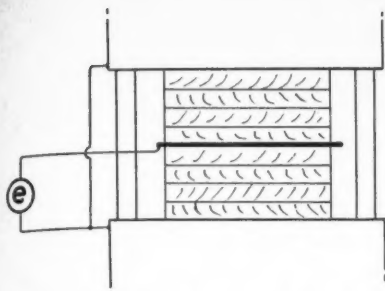
The value of the power factor $P.F.$ can easily be measured by means of a radio-frequency bridge or Q -meter. The power factor of a material is usually thought of as a constant. (However, recent measurements show that $P.F.$ varies considerably with frequency, moisture and impregnation.) For the calculation as here an approximate value will suffice.

Having determined R_p it now remains to note that the power delivered to the wood and which appears as heat is given by:

$$P = i_R^2 R_p \quad (3)$$



Typical setup of gluing one assembly at a time. The insulator must have good loss characteristics if a large waste of power is to be avoided.



The "sandwich" method whereby two assemblies are made at once. This setup requires no insulating material and insures high efficiency.

If we have calculated (as described below) the amount of power required to heat the material, we will know P and from (3) we can calculate i_R . Then, since:

$$E = i_R R_p \quad (4)$$

we also obtain the value of E which is the voltage which will be required to force through the wood the current necessary to heat it in the desired amount.

If we now substitute some actual values in the above calculations we will immediately perceive the reason for using high frequencies.

Example 1: It is desired to use 60-cycle current to heat a test propeller to 240° . By the method shown below it has been calculated that a power of 6000 watts is required to do this in a time of eight minutes. By calculation C was found to be 150 micromicrofarads; hence, from (2):

$$X_c = \frac{1}{2\pi f c} = \frac{1}{6.28 \times 60 \times 150 \times 10^{-12}}$$

and from (1):

$$X_c = \frac{17,700,000}{.05} = 354,000,000 \text{ ohms (taking } P.F. = .05)$$

and from (3):

$$P = i_R^2 R_p$$

$$P = 6000, R_p = 354,000,000$$

$$i_R^2 = \frac{6000}{354,000,000}$$

$$i_R = 4.13 \times 10^{-3} \text{ amp.}$$

and from (4)

$$E = i_R R_p = 4.13 \times 10^{-3} \times 354 \times 10^6 = 1,460,000 \text{ volts.}$$

In other words, the desired heating could be accomplished with 60-cycle current only by the use of an entirely impractical voltage.

Example 2: Now assume that the same block is to be heated with current at a frequency of 1 mc.:

from (2):

$$X_c = \frac{1}{2\pi f c} = \frac{1}{6.28 \times 10^6 \times 150 \times 10^{-12}} = \frac{10^6}{943}$$

$$X_c = 1010 \text{ ohms}$$

from (1):

$$R_p = \frac{1010}{.05} = 20,200 \text{ ohms}$$

from (3):

$$P = i_R^2 R_p = 6000$$

$$i_R^2 = \frac{6000}{20,200} = .297$$

$$i_R = .545 \text{ amp.}$$

from (4):

$$E = i_R R_p = .545 \times 20,200$$

$$E = 11,000 \text{ volts}$$

In other words, if we use 1-megacycle current we can operate with 11,000 volts across the load. We might go still higher, say, to 10 megacycles, in which case the required voltage would drop to 3480 volts. In order to show this effect of frequency graphically the values of X_c , R_p and E for a large range of frequencies have been plotted in Fig. 5.

As can be seen from this figure, the voltage required for a given power input (i.e. a given heating effect) is inversely proportional to the square root of the frequency. This means that, generally speaking, the higher the fre-

quency the better, although a practical limitation is encountered due to the fact that the efficiencies of some types of tubes fall off at the higher frequencies. There may also be difficulties due to current distribution at the higher frequencies. The actual maximum voltage that can be tolerated will depend chiefly on the thickness of the load. For very thin materials not more than a few hundred volts can be used before arc-over occurs. In thicker sections as much as 15,000 volts can be used. Generally, voltages much above 15,000 cannot be used, no matter what the thickness, due to corona effects which become evident at higher voltages and which are only partially dependent on electrical spacing.

Averaging these various factors together, it has been found that the range of 1 megacycle to 10 megacycles presents the best immediate possibilities. Some very thin sections, however, will require higher frequencies—and looking to the future (when a wider choice of high-frequency tubes will presumably be available) it seems very prob-

[Continued on page 57]

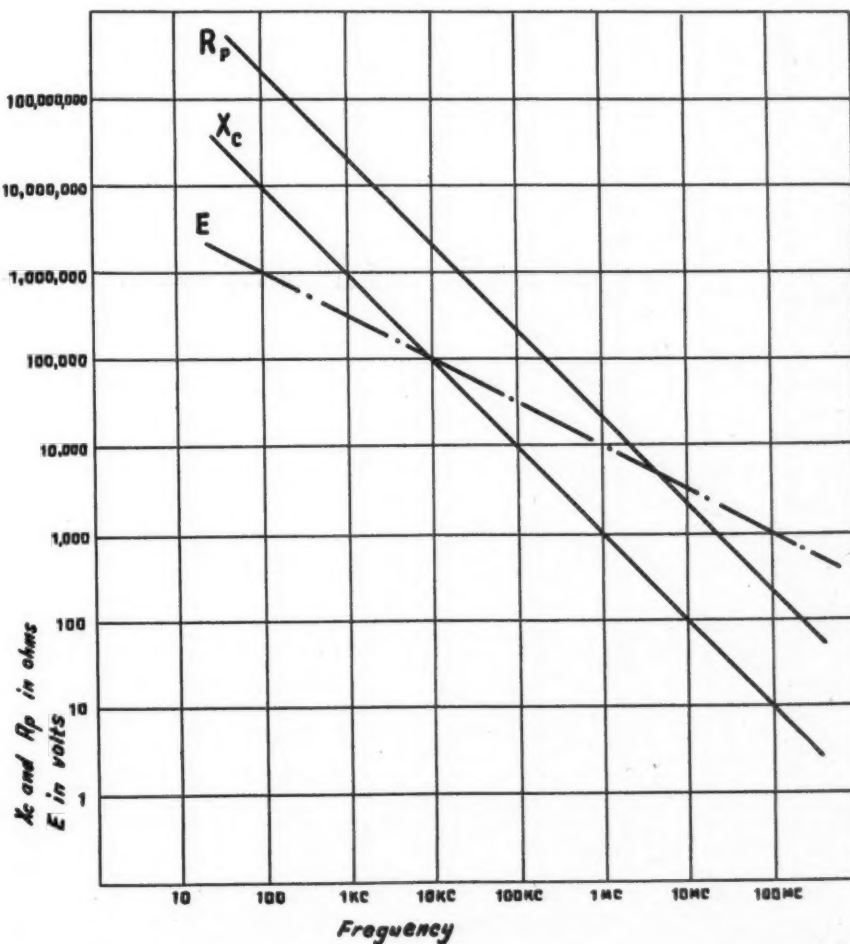


Fig. 5. Variation with frequency of the reactance X_c , the equivalent resistance R_p and the voltage E across the load for a typical radio frequency heating setup. Note that the voltage E varies inversely as the frequency; hence, higher frequencies mean less danger of voltage flash-over.

THIS MONTH

W. E. LICENSE CONTRACTS

T. K. Stevenson, Vice President of the Western Electric Company, announces that contractual notice has been given of the Company's intention to terminate two years hence its license contracts with the motion picture producers in this country operating under Bell System sound recording patents. This is the well-known Western Electric sound system.

Mr. Stevenson said that early in 1941, as the time approached when notice of cancellation could first be given under existing contracts, Western Electric advised its licensees that if and when it terminated the present contracts there would be available to its licensees another form of contract which would continue to make available Bell System patents for sound recording in the motion picture field. The new contract, a draft of which will shortly be presented to licensees, will run to the end of 1954 and will provide for substantially lower recording fees.

RCA UNIFICATION

The RCA Manufacturing Company, wholly-owned subsidiary of Radio Corporation of America, has been consolidated with the parent company, David Sarnoff, RCA President, announced following a special meeting of the RCA Board of Directors.



A research production line in the new Motorola Engineering Building. Motorola Engineers are at work on special radio problems assigned to them by U. S. Government.

The RCA Manufacturing Company has approximately 30,000 employees, and is now chiefly engaged in producing radio equipment vital to the war effort. The manufacturing organization will be known as the RCA Victor Division of Radio Corporation of America. The management, personnel, operations and sales policies will continue as heretofore.

★

ACTIONS BY FCC

The Commission en banc Dec. 8 and 15 took the following action on Rules and Regulations:

Amateur-Commercial

Adopted Order No. 77-B, suspending from January 1, 1943, until further order of the Commission, but in no event beyond January 1, 1944, Sections 12.26, 12.66 of the Rules Governing Amateur Radio Service and Section 13.28 of the Rules Governing Commercial Radio Operators, in so far as the required showing of service in connection with renewal of license is concerned. This Order continues in effect the provisions of Order No. 77-A, issued December 3, 1941 to expire not later than January 1, 1943.

Police Radio

Amended Part 10 of the Rules Governing Emergency Radio Services:

(a) Section 10.41—State and mu-



James Watson, vice president of Meissner Manufacturing Co., and Captain Robert Henderson, examining the 5-millionth Meissner coil produced since "Pearl Harbor."

nicipal police stations (frequencies below 2500 kilocycles.) The amendment does not change the frequencies available or the method of assignment to state and municipal police stations. Power authorizations for municipal police stations operating on frequencies below 2500 kilocycles will continue to be based on the official population figures of the Department of Commerce in accordance with the present table in Section 10.121. The maximum power normally to be assigned to state police stations operating on these frequencies will be limited to 500 watts. Authorizations for both state and municipal police stations involving the use of power in excess of that specified would be granted only on the basis of a showing of need made by the applicant.

(b) Section 10.42—State and municipal police stations (30,000 to 40,000 kilocycles)—The amendment does not alter the present allocation of frequencies or the assignment of frequencies to the various classes of stations. The amended rule normally establishes a maximum power of 250 watts. Power in excess of the 250 watt limitation may be granted only on the basis of a showing of need submitted by the applicant.

(c) Section 10.122 permits municipal and state police stations to communicate with Government stations, stations in the War Emergency Radio Service, or with other stations which are authorized to communicate with municipal and state police stations.

[Continued on page 59]

RADIO DESIGN WORKSHEET

No. 9—IMPEDANCE RELATIONS; COUPLED CIRCUITS

IMPEDANCE RELATIONS

Problem 1: Determine the relations between the impedances of the circuit of Fig. 1 so that the current flowing through the load R will be independent of the value of R .

Solution: First we may determine the value of I_3 by Thevenin's Theorem, which has been given before*; whence impedance Z looking back from R into the network with E short-circuited is:

$$Z = \frac{AB}{(A+B)}$$

The open-circuit voltage V across terminals 1 and 2 with R removed is:

$$V = BI'$$

But

$$I_1 = \frac{E}{(A+B)}$$

Whence

$$V = \frac{BE}{(A+B)}$$

$$I_3 = \frac{V}{(Z+R)} \quad \text{But } Z+R = R + \frac{AB}{(A+B)} = \frac{AR+BR+AB}{(A+B)}$$

Whence

$$I_3 = \frac{BE}{(A+B)} \times \frac{(A+B)}{AR+BR+AB} = \frac{BE}{R(A+B)+AB}$$

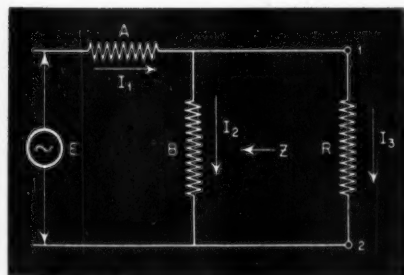


FIG. 1

Now if A is an inductance and B is a capacitance, we have at resonant frequency: $A+B=0$

Whence:

$$I_3 = \frac{B}{AB} E$$

This indicates that the current

through impedance R is under conditions of series resonance for A and B independent of the magnitude of R and dependent only on the voltage E and the magnitudes of impedances B and A .

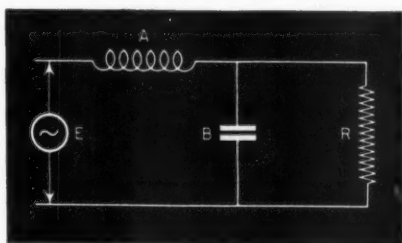


FIG. 2

Fig. 1 then becomes Fig. 2, wherein $A = j\omega L$ and $B = 1/j\omega C$. This is a circuit that has had extensive use in series arc-light systems as well as in wire-line communication systems. In the latter case the line impedance varies with weather and if power supply current for tubes in unattended repeaters, or radio receivers or transmitters, is to be supplied over the line, a constant-current circuit is necessary. Of course, A or B may be either a capacitance or an inductance so long as A and B are in resonance. Thus, if $A = 1/j\omega C$, then B must equal $j\omega L$. Thus the relation becomes $j\omega L = 1/j\omega C$, or: $\omega^2 LC = 1$.

COUPLED CIRCUITS

Problem 2: Establish the relations between the circuit constants and bandwidth of critically coupled (inductive) and over-coupled circuits.

Solution: Let Fig. 3 represent the inductively coupled circuits.

$$Z_1 = R_1 + j(\omega L_1 - 1/\omega C_1) = \frac{\omega^2 L_1 C_1 - 1}{R_1 + j\omega L_1(1 - 1/\omega^2 L_1 C_1)}$$

Let $F = \omega/\omega_0$

Where ω is $2\pi \times$ frequency under consideration,

ω_0 is $2\pi \times$ frequency at resonance.

$$\omega_0 L_1 = 1/\omega_0 C_1$$

$1/\omega_0^2 L_1 C_1 = 1$ by definition of resonance.

Substituting:

$$\frac{\omega^2 L_1 C_1 - 1}{\omega^2 L_1 C_1} = \frac{\omega^2 - \omega_0^2}{\omega_0^2}$$

* Thevenin's Theorem, page 23, October, 1942.

Simplifying:

$$\omega^2 = \omega_0^2 L_1 C_1$$

Whence:

$$1 - 1/\omega^2 L_1 C_1 = 1 - 1/F^2$$

Therefore:

$$Z_1 = R_1 + j\omega L_1(1 - 1/F^2)$$

Also

$$Z_2 = R_2 + j(\omega L_2 - 1/\omega C_2) = R_2 + j\omega L_2(1 - 1/\omega^2 L_2 C_2) = R_2 + j\omega L_2(1 - 1/F^2)$$

$$I_3 = \frac{jE\omega M}{\omega^2 L_1 L_2 + \omega^2 M^2 + j(1 - 1/F^2)(\omega L_1 R_2 + \omega L_2 R_1)} \quad (1)$$

$$\text{Let: } Q_1 = \omega L_1/R_1, \quad Q_2 = \omega L_2/R_2, \quad M = \sqrt{L_1 L_2}, \quad K = M/\sqrt{L_1 L_2}$$

Multiplying (1) by $\frac{\omega^2 L_1 L_2}{\omega^2 L_1 L_2}$ we have:

$$I_3 = -jEK \div F\omega_0 \sqrt{L_1 L_2} [K^2 + 1/Q_1 Q_2 - (1 - 1/F^2)^2 + j(1 - 1/F^2)(1/Q_1 + 1/Q_2)] \quad (2)$$

Conditions for maximum secondary current are: circuits 1 and 2 are in resonance

$$(\omega M)^2/R_2 = R_1 \text{ or } \omega M = \sqrt{R_1 R_2}$$

This condition is called critical coupling:

$$K = M/\sqrt{L_1 L_2} = 1/\sqrt{Q_1 Q_2}$$

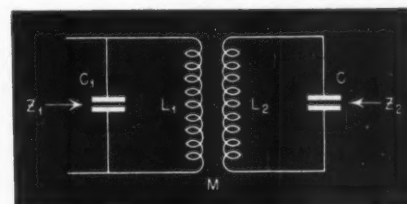


FIG. 3

Whence (1) reduces to:

$$I_3 = \frac{-jE_1 K}{\omega_0 \sqrt{L_1 L_2} (K^2 + 1/Q_1 Q_2)} = \frac{-jE \sqrt{Q_1 Q_2}}{2\omega_0 \sqrt{L_1 L_2}} = -j \frac{E}{2\sqrt{R_1 R_2}} \quad (3)$$

If the coupling exceeds the critical value the response curve will depart from the single hump and two humps will appear, as in Fig. 4. The secondary current at each hump will be equal to resonance secondary current with critical coupling. The spacing of the humps is a function of the ratio of coupling to critical coupling. When the coupling is considerably above critical, then the humps occur at prac-

[Continued on page 28]

tically the same frequencies as if $R_1 = R_2 = 0$.

Assume $R_1 = R_2 = 0$, or $Q_1 = Q_2 = \infty$ (i.e., zero losses). Then, from (2):

$$I_2 = \frac{-jEK}{F\omega_0\sqrt{L_1L_2}[K^2 - (1-1/F^2)^2]} = 0$$

I_2 will equal infinity if

$$F\omega_0\sqrt{L_1L_2}[K^2 - (1-1/F^2)^2] = 0$$

or:

$$K^2 = (1-1/F^2)^2 \quad (4)$$

Whence:

$$F = \omega/\omega_0 = 1/\sqrt{1 \pm K} \quad (5)$$

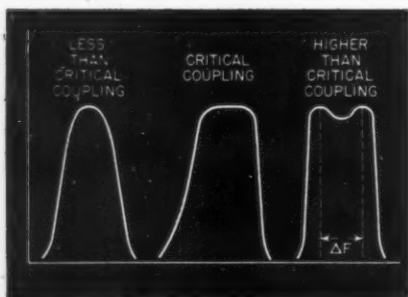


FIG. 4

From (5) the bandwidth ΔF between humps is related to resonance frequency $\omega_0/2\pi = f_0$ by:

$$\frac{\Delta F}{f_0} = \frac{\sqrt{1+K} - \sqrt{1-K}}{\sqrt{1-K^2}}$$

If K is very small, as is generally the case in practice, then

$$\Delta F/f_0 = K$$

Also, at critical coupling: $E_2/E_1 = Q_1/2 =$ circuit voltage step up if $Q_1 = Q_2$. From this it is obvious that the Q of the combination is less than the Q of either circuit. If $Q_1 = Q_2$ the effective Q of the coupled combination is $Q_1/2 = Q_2/2$. Obviously the response of the coupled circuit at critical coupling if $Q_1 = Q_2$ is down 6 db on the response of either circuit used alone.

TRANSFORMER PRIMARY INDUCTANCE

Problem 3: Determine from a practical design standpoint the relative magnitude of the primary inductance of an interstage audio transformer to prevent undue loss of low-frequency response.

Solution: Let Fig. 5 represent the equivalent circuit of an input or interstage transformer, and in which Z_1 is the primary impedance with secondary open circuited, and Z_2 the secondary

impedance with primary on open circuit.

The transformer turns ratio is:

$$N = \sqrt{L_2/L_1}$$

At low frequencies, the input impedance of the tube fed by the transformer is large, so that to a first approximation the impedance looking into the primary is:

$$Z_1 = R_1 + jX_1$$

Whence $I_1 = E_1/R_1 + jX_1$ nearly.

At low frequencies, it is justifiable to neglect Z_2 in comparison with Z_3 . Then:

$$I_2 = \frac{\omega ME_1}{(R_0 + jX_1)Z_3} \text{ approximately.}$$

Now, the coefficient of coupling of the transformer is:

$$K = \frac{M}{\sqrt{L_1L_2}}$$

If $K = 1$

$$M = \sqrt{L_1L_2}$$

and

$$\omega M = \sqrt{X_1X_2}$$

when $\omega = 2\pi \times$ frequency in question.

By definition:

$$N^2 = \frac{X_2}{X_1}$$

Or

$$N^2 X_1^2 = X_2 X_1$$

$$NX_1 = \sqrt{X_1 X_2} = \omega M$$

Whence:

$$I_2 = \frac{NX_1 E_1}{(R_0 + jX_1)Z_3}$$

And:

$$E_2 = Z_3 I_2 = \frac{\omega ME_1}{(R_0 + jX_1)}$$

Let: $A = E_2/E_1$

Then:

$$A^2 = \frac{\omega^2 M^2}{(R_0 + jX_1)^2} = \frac{\omega^2 M^2}{R_0^2 + X_1^2} = \frac{N^2 X_1^2}{R_0^2 + X_1^2}$$

From practical considerations let:

$$\omega^2 M^2 / X_1 = N^2 X_1 = B$$

Whence:

$$A^2 = \frac{N^2 X_1^2}{R_0^2 + X_1^2} = \frac{N^2 B^2}{N^4 (R_0^2 + X_1^2)} = \frac{N^2 B^2}{N^4 R_0^2 + B^2}$$

Setting $\delta/\delta N (A^2) = 0$ to solve for maximum.

We have:

$$N^2 B^2 (4N^3 R_0^2) = 2NB^2 (N^4 R_0^2 + B^2)$$

That is:

A is a maximum when:

$$B = N^2 R_0$$

$$\text{or } R_0 = X_1$$

For any higher frequency, say, $\omega_1 = 2\pi f_1$:

$$X_1 = \omega_1 L_1 = \frac{\omega_1}{\omega} R_0$$

And

$$A^2 = \frac{N^2 R_0^2 \omega_1^2 / \omega^2}{R_0^2 (\omega^2 + \omega_1^2 / \omega^2)}$$

And $A = N$ when $\omega_1 \gg \omega$

Therefore the frequency at which $X_1 = R_0$ holds should be well below the desired low-frequency cutoff.

As a practical case, assume that it is required that the response of an interstage transformer be relatively uniform down to say 60 cycles (i.e., $\omega_1 = 2\pi \times 60$).

If $\omega_1 = 3\omega$

$$A = \frac{N^2 R_0^2 9\omega^2 / \omega^2}{R_0^2 (\omega^2 + 9\omega^2 / \omega^2)} = \frac{9N^2 R_0^2}{10R_0^2} = 0.9N^2$$

$$A = .95 N$$

If $R_0 = 10,000$ ohms, then:

$$L_1 = R_0 / \omega = 10,000 / 2\pi \times 20 = 80 \text{ henrys.}$$

Had ten times 80 henrys been employed the gain in response would have been something less than .5 db, and had three times 80 henrys been used the gain at 60 cycles would have been about .25 db.

The relation of $\omega_1 = 3\omega$ is a fair value in all ordinary cases. However, in some especially critical transformers, a higher value might be justified. To illustrate, assume: $\omega_1 = 6\omega$.

$$A^2 = \frac{36}{37} N^2 = .97N^2$$

$$A = .985N$$

$$L_1 = 10,000 / 2\pi \times 10 = 160 \text{ henrys.}$$

Obviously the loss due to primary impedance alone would amount to about 0.1 db at 60 cycles.

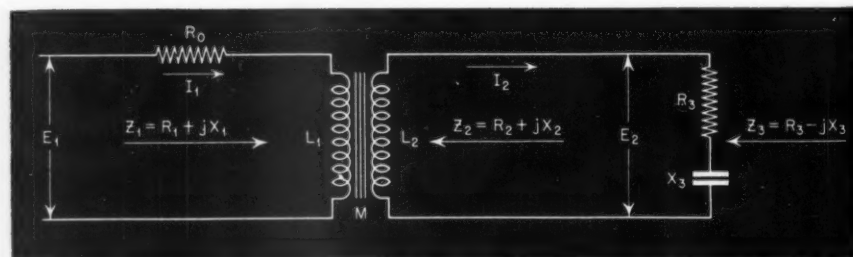


FIG. 5



Echophone Model EC-1

6 tubes, 3 bands. Tunes from 550 kc. to 30 mc. Beat frequency oscillator. Bandsread logging scale. Self-contained speaker. Electrical bandsread on all bands. AC/DC. 115-125 volts.

ECHOPHONE RADIO CO., 201 EAST 26TH ST., CHICAGO, ILLINOIS

PVT. KILDAY
CAMP LEE

AIRCRAFT RADIO MAINTENANCE

GERALD O. CROWLEY

★ The maintenance of aircraft radio equipment differs radically from the ordinary type of radio servicing. This is due in part to the advanced design of aircraft radio and the severe usage to which such equipment is subjected. But more unique is the cardinal rule that aircraft radio equipment, like aircraft engines, *must not fail in service.*

A dependable communications system is an important essential to any

form of flight activity. In peace or war, the conduct of operations above the surface of the earth is controlled by this thin bond with the ground below. With the speed of our latest pursuit ships already surpassing that of sound waves, radio alone can provide such a means of communication.

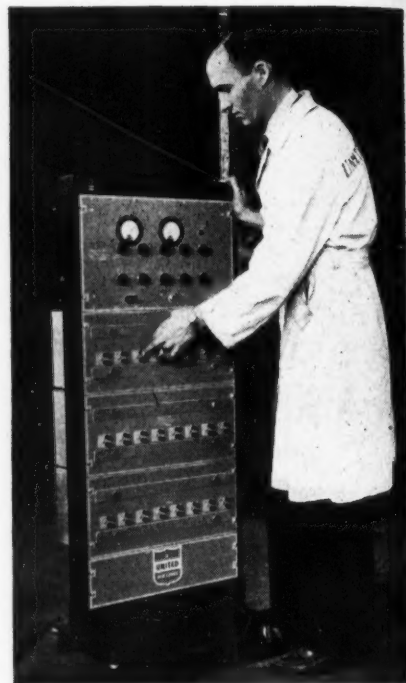
Removed from the living room and installed in an airplane, a radio receiver loses its common identity as a means of entertainment. Aside from its value as a communications unit, in its new role it has also become a vital adjunct to the plane's complement of flight instruments. When a household radio sputters and goes dead a portion of a football game or news broadcast may be lost to the listener. But when aircraft radio equipment fails in service the results are not pleasant to contemplate: A torpedo bomber—searching vainly for its carrier—crashes into the sea out of fuel. Or an airline transport with its human cargo becomes a flaming pyre on a desolate mountain top.

Aircraft radio engineers, specialists in their field, have made a persistent and methodic study of the causes of aircraft radio equipment service failures. Their practical findings provide a solid foundation for the service routine followed by airline radio maintenance departments. "Pre-failure radio maintenance" — periodic overhauling of equipment while still in satisfactory operating condition—has proved to be the one really successful means of preventing radio failures in flight. Such a system, of course, depends upon rigid adherence of maintenance personnel to established testing and maintenance procedures.

Maintenance Routine

As practiced by one major airline, radio equipment receives a daily check,

Shake tester, for jogging transmitters, receivers, mikes, etc., to show up mechanical or electrical faults. (Photo courtesy United Airlines).



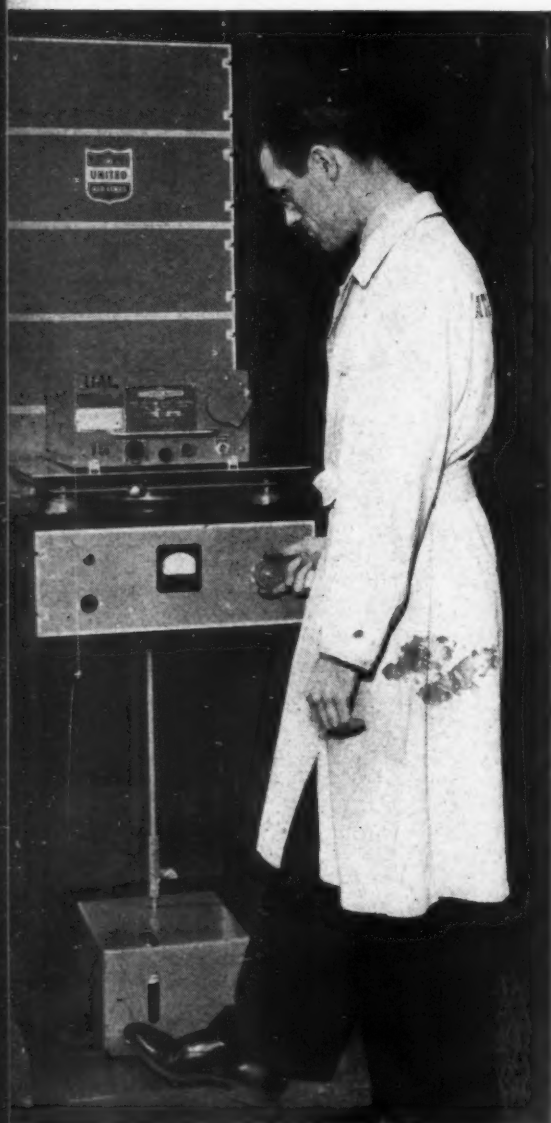
Crystal-controlled push-button signal generator for test and alignment purposes. (Photo courtesy United Airlines).

a thirty day (250-hour service) removable equipment overhaul, a ninety day (750-hour service) complete equipment overhaul and a 5000-hour major overhaul. Maintenance routine is firmly established for each of these service periods and technicians follow procedures to the letter. The practicability of this company's system is attested to by their remarkably low record of radio service failures.

A typical radio installation in an airline transport plane will include the following pieces of equipment:

- 1—Two-way radio-telephone communications unit.
- 2—Long-wave radio range (beam) receiver.
- 3—A.D.F. range receiver or radio compass.
- 4—Ultra-high-frequency marker beacon receiver.
- 5—Pilots' interphone amplifier.

[Continued on page 32]



A NEW

BUILDING

DEVOTED EXCLUSIVELY TO ELECTRONIC

Research and Engineering



When war came, Motorola research and engineering was already at work around the clock on special assignments for our Armed Forces. Now in its new home, the Motorola staff of engineers and technicians is by specific government assignments at work on problems which embrace many important phases of electronic knowledge. This new Motorola engineering building increases many times our capacity for service of the highest order.

THE ARMY-NAVY "E"

Awarded for excellence in the production of Communications Equipment for America's Armed Forces



Photo Courtesy U. S. Army Signal Corps

**Motorola Radio Communication Systems
Designed and Engineered to Fit Special Needs**

In addition to the above units are numerous pieces of auxiliary equipment. Under this heading is found transmitting and receiving dynamotors, antennae, microphones, headsets, control panels, jack boxes, range filters, marker beacon visual indicators, control heads and cables, azimuth indicators, antistatic cartridges and relays. To keep this imposing array of radio apparatus in perfect operating condition is the formidable task of the radio maintenance department.

The daily radio check takes the form of operational tests of each piece of equipment prior to and at the completion of each flight. The pilot's log book furnishes a record of radio performance in flight. When a report of radio malfunctioning is noted, the suspected piece of equipment is replaced with a tested unit and sent to the shop for complete overhaul. Visual inspections are also made daily of antennae, microphone and headset cords and other easily accessible accessories.

At the thirty-day check period each major piece of radio equipment is removed from the ship for a complete bench overhaul. Service benches have complete facilities necessary for the repair and alignment of all units. A double-screened test room is fitted with testing instruments equaled only by those found in engineering laboratories. A complete overhaul procedure for each unit is available to the technician in a handy reference file. Liberal stocks of replacement parts encourage personnel to replace doubtful or worn components.

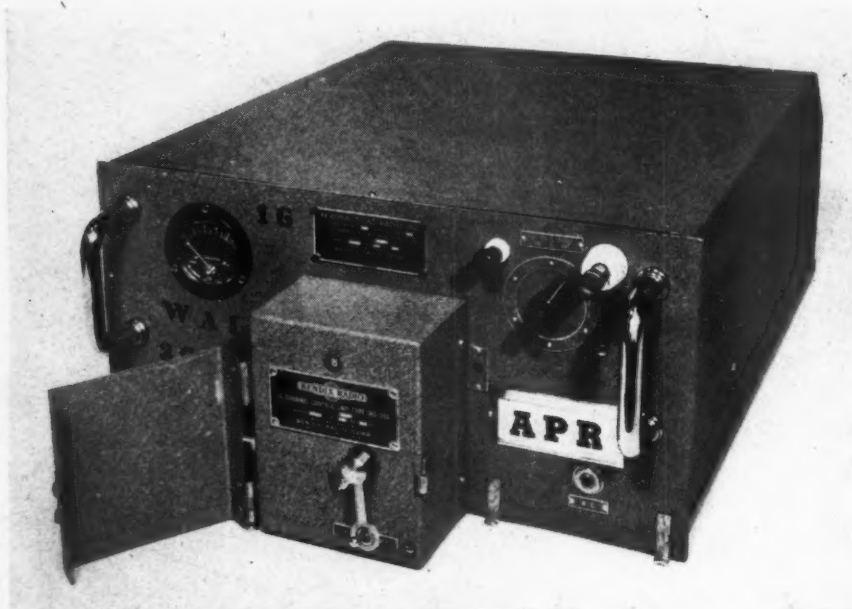
Test Procedure

Overhaul of transmitters and receivers



Rear view of main radio control panel. Multiple plug allows for easy service removal. Leads and resistors are tied down. (Photo by Western Airlines).

begins usually with a careful visual inspection of all parts and connections. Following this all tubes are tested. Particular care is exercised to reject any tube with a tendency to produce noise under vibration. Such tubes are detected by the familiar method of tapping them with a small rubber hammer while the set is hooked up on the bench with gain controlling adjustments set to a point of high sensitivity. Tuning condenser wiper contacts, range switch contacts and relay points are thoroughly cleaned with carbon-tetrachloride. Relay points are further attended with a burnishing tool and adjusted to operate with seventy-five per cent of normal operating voltage. Vibrators are given starting tests at reduced voltage and replaced if sluggish in action. The rubber hammer is used on all bypass condensers, sockets and other small parts to reveal poor swaged or soldered connections.



Aircraft communications unit showing overhaul date card mounted on face. (Photo courtesy Western Airlines).

When replacement of a component is made, particular attention is paid to the fastening down of the part and to the soldering of its connections. Condensers or resistors cannot be hung by their leads as the vibration encountered in aircraft use would soon cause the leads to break off. The same is true of cold soldered connections. Aircraft radio technicians soon become masters at the too-rare art of soldering.

Having passed these preliminary vibration tests, the unit is given a ride on the bounce-table. Here in a few minutes it undergoes a jolting equivalent to hours of aircraft service. Surviving this with flying colors, the unit is ready for alignment. All aligning is done with frequency-modulated signal generators and oscilloscopes. Measurements are made of i.f. sensitivity and bandwidth, overall sensitivity, signal-to-noise ratio, image attenuation, a.v.c. action and power output. Exacting manufacturers' standards of performance must be met without compromise. Transmitters are further tested after alignment for oscillator starting, percentage of modulation and distortion, audio frequency response and sidetone. Radio compasses, in addition to the receiver tests, are checked for loop speed, orientation, accuracy and hunting. After a final air check units are ready to be installed in the ship.

Shop and Service Records

An important detail is the record system used to keep tab on overhaul dates. In addition to shop records a permanent service record accompanies each piece of equipment. This is a small record book kept in the unit itself. It is referred to each time the unit is serviced. An easily identified card bearing the next overhaul due date is also fastened to the outside face of each unit. A glance at the radio rack will reveal instantly the pieces of equipment which are due for overhaul.

Other removable equipment serviced during the thirty-day check include headsets, microphones, dynamotors, control heads and drive cables. Headsets are checked for sensitivity and response and worn headbands and cords replaced. Microphones are repacked and push-to-talk switches are cleaned, burnished and adjusted. Dynamotor commutators are cleaned or, if necessary, lathe-turned and undercut. Brushes and solenoid contacts are replaced. Control heads and cables are checked for rough action and backlash and overhauled if more than a minimum of either is evident.

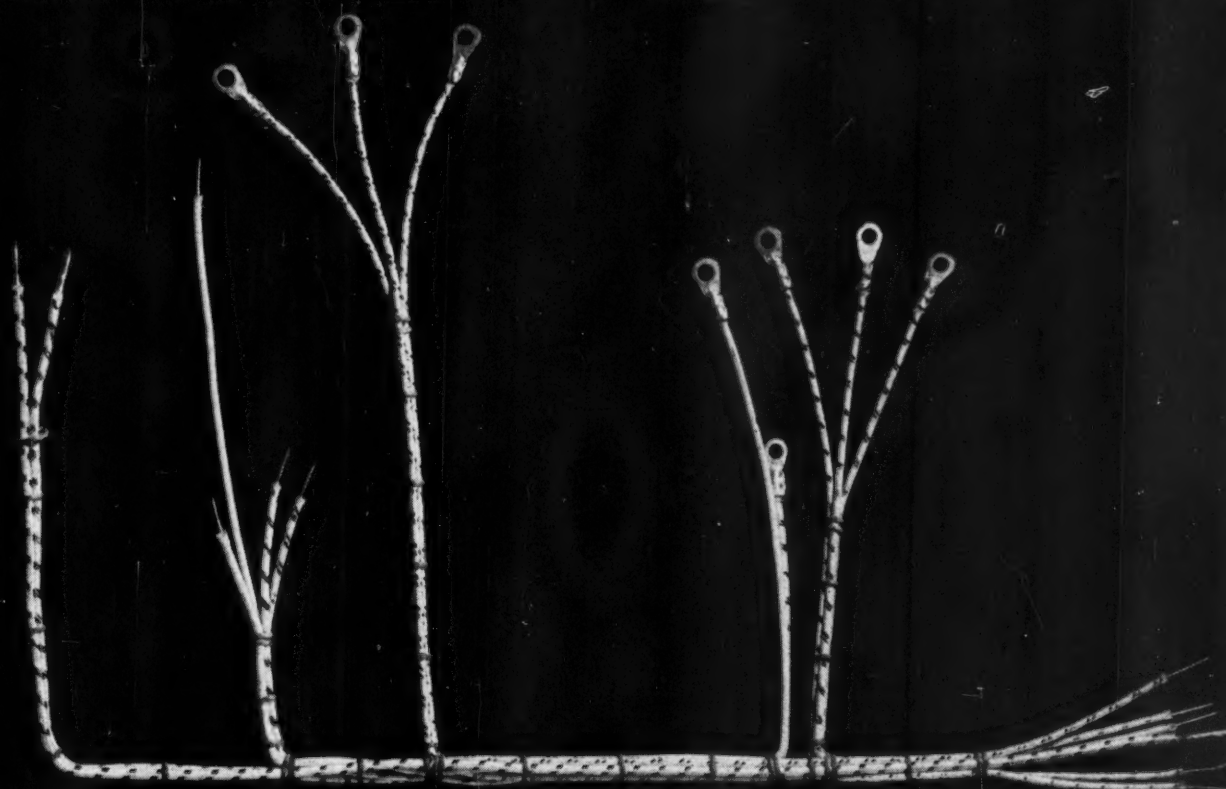
During the ninety-day overhaul, all the foregoing is performed and, in addition, all the fixed equipment in the ship receives a thorough going-over.

[Continued on page 56]



LACED WIRING HARNESS

FOR COMMUNICATIONS EQUIPMENT



Expedite Wiring Operations

A sure cure for wiring "headaches". Constructed entirely of wires with approved types of color coded insulation, assembled exactly in accordance with your specifications, Lenz Laced Wiring Harnesses will speed up your wiring operations and permit the release of some of

your important labor to other assembly tasks.

Make the Lenz organization a part of your factory. A Lenz Wire engineer will be glad to consult with you on your requirements. Quotations will be gladly furnished on receipt of specifications and sketch.



IN BUSINESS

SINCE 1904

LENZ ELECTRIC MANUFACTURING CO.

1751 NORTH WESTERN AVENUE • CHICAGO, ILLINOIS

RADIO

★ JANUARY, 1943

33

The **TRIPLETT** **ELECTRICAL**

Passing

The advertisement features a central collage of various Triplett electrical instruments. At the top left, a stylized illustration of a car is shown. Below it, a pilot wearing goggles is depicted. To the right, a technician is shown working on a piece of equipment. The instruments include:

- A circular instrument labeled 'LEFT TURN' and 'RIGHT TURN'.
- A semi-circular instrument labeled 'MICROAMMETERS'.
- A rectangular instrument with two scales labeled 'D.C. AMPERES'.
- A semi-circular instrument labeled 'D.C. AMPERES'.
- A circular instrument labeled 'D.C. MILLIAMPERES'.
- A rectangular instrument labeled 'D.C. MILLIAMPERES'.
- A semi-circular instrument labeled 'D.C. MILLIAMPERES'.
- A rectangular instrument labeled 'A.C. VOLTS'.
- A large rectangular instrument labeled 'TRIPOLET'.

THE TRIPLETT ELECTRICAL INSTRUMENT CO.

A WORD ABOUT DELIVERIES

Naturally deliveries are subject to necessary priority regulations. We urge prompt filing of orders for delivery as may be consistent with America's War effort.

Combat Line

MEASURING INSTRUMENTS

in Review

BLUFFTON, OHIO ★ ★ ★ ★

TRIPOLET

A Glimpse into the Future

Out of the needs of war; out of tripled production lines and twenty-four hour days; out of the drive for "better performance under spectacular stress and vibration," comes Triplet precision instruments in volumes impossible by now outmoded peacetime methods. Today our country's needs come first—Tomorrow when America again takes up peacetime pursuits, the values of these experiences will be apparent, in savings, in performance, in technical superiority beyond the concepts of yesterday.

Q. & A. STUDY GUIDE

C. RADIUS

RCA Institutes

VACUUM TUBES—2

TRIODE CHARACTERISTICS

16. Describe the physical construction of a triode electron tube. (II-126).

17. What is the primary purpose of the control grid of a triode? (V-64).

As the name implies, a triode contains three elements or electrodes, the electron emitter of filament or cathode type, a wire grid surrounding the emitter, and a plate enclosing the elements. By applying a varying potential to the grid it is possible to control the space charge which is made up of a cloud of electrons around the cathode, and thus control the flow of electrons from the cathode to the plate.

18. What is the meaning of the term 'plate-saturation'? (II-147).

19. What is the meaning of plate impedance? (II-129).

20. What is the meaning of mutual conductance? Transconductance? (II-130).

21. If the plate current of a vacuum tube changed 5 milliamperes for a grid voltage change of 2.5 volts, what is the value of the transconductance? (II-284).

22. What is the meaning of amplification factor? (II-132).

Fig. 1 shows how the plate current, I_p , varies with the plate potential, E_p , when the grid potential is being held constant. It is apparent that beyond a certain plate potential the plate current ceases to increase. This is the condition in which all the electrons reach

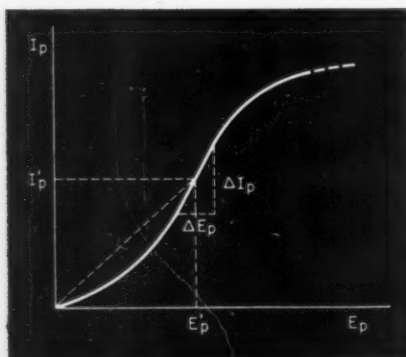


Fig. 1. Showing how plate current varies with plate voltage when grid voltage is held constant.

the plate and is known as 'plate saturation'.

The plate impedance, r_p , is the effective plate-to-cathode resistance of the tube. It is given by the ratio of the plate voltage change ΔE_p , to the plate current change ΔI_p , for constant grid voltage. In the case of triodes r_p ranges in value between 800 and 150,000 ohms. The ratio of E_p to I_p is the d-c resistance which would determine the voltage drop across the tube when no signal is applied to the grid.

Fig. 2 shows how the plate current varies with the grid potential, E_g , when the plate potential is being held constant. The ratio of the change in plate current ΔI_p , to the change in grid potential ΔE_g , is known as the mutual conductance or transconductance g_m . It is frequently defined as the change of plate current for a change of 1 volt on the grid. If a change of 2.5 volts on the grid causes a 5-milliamperere change in plate current, the transcon-

ductance is given by $\frac{5}{2.5} \times 10^3 = 2000$ micromhos.

For triodes g_m varies from 200 to 5000 micromhos. This is the important characteristic in the choice of power tubes.

Since the grid is located in the middle of the space charge its potential is more effective in controlling the plate current than the plate potential. Ideally, the plate potential should not control the plate current. The real function of the plate is to collect the electrons. The ratio of ΔE_p to ΔE_g with constant plate current is the amplification factor, μ , of the tube. For the most triodes the values of μ range from 10 to 100.

23. What is the purpose of a bias voltage on the grid of an audio amplifier tube? (II-144).

24. What are the factors which determine the bias voltage for the grid of a vacuum tube? (II-170).

25. Draw a grid voltage-plate current characteristic curve of a vacuum tube and indicate the operating points for 'Class A', 'Class B', and 'Class C' amplifier operations. (II-152).

26. What is meant by a blocked grid? (II-141).

All tubes used in audio-frequency amplifiers operate with the grid held

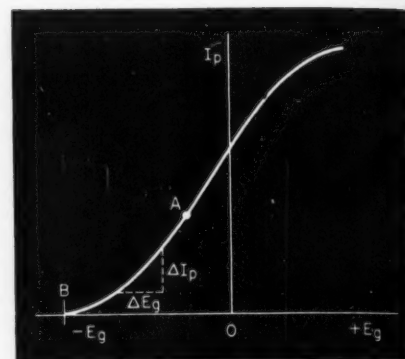


Fig. 2. Grid-voltage plate-current curve, illustrating Class A, B and C operation.

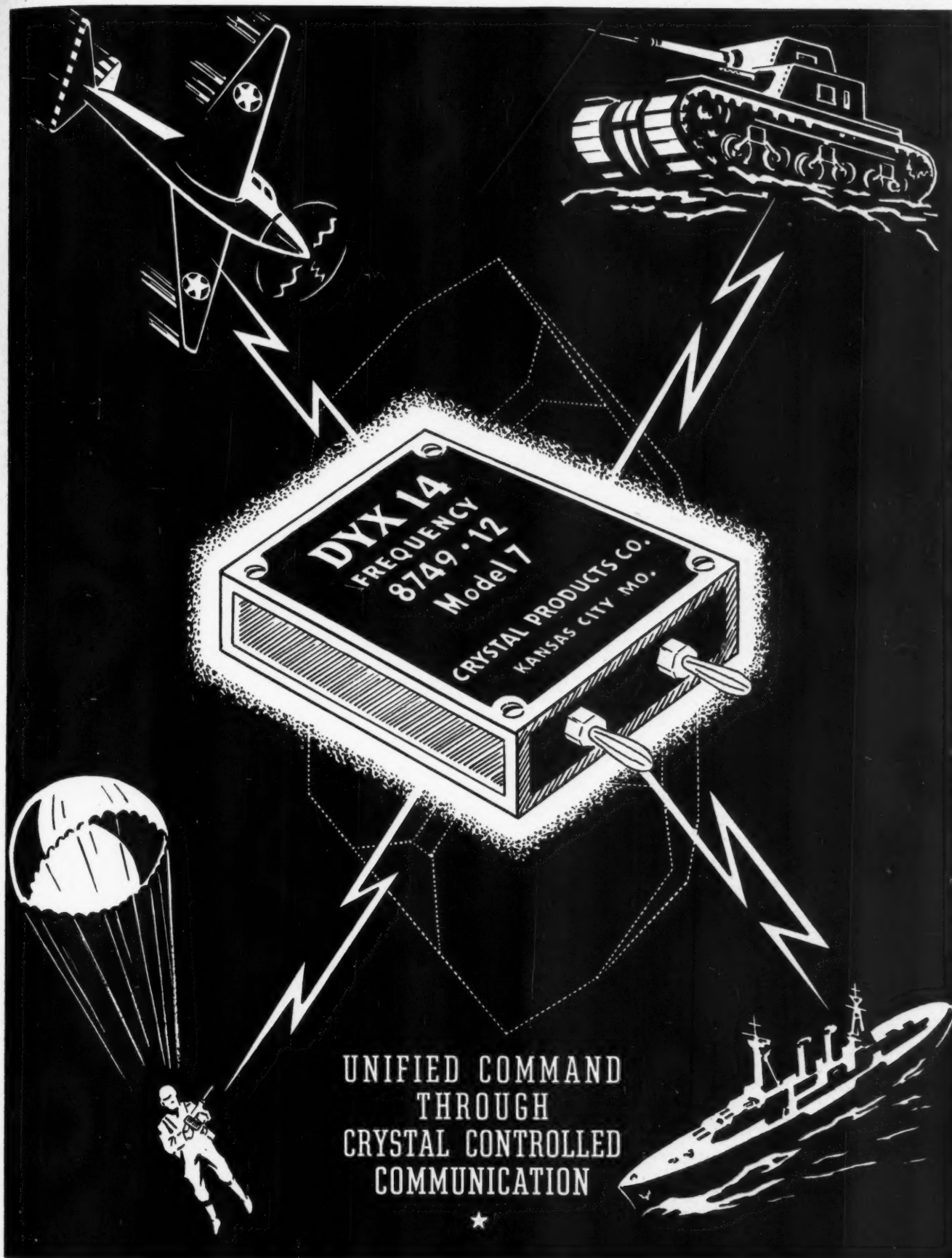
at a negative potential ranging from zero to cutoff. When an alternating potential is applied between grid and cathode, the plate current will likewise contain an alternating component. If the tube is biased at point A in Fig. 2, the plate current variation will be similar to the grid potential variation; the I_p - E_g curve being practically a straight line (linear) in this range. The maximum value of the signal should not exceed the bias voltage. This method of operation is known as Class A. It is obvious that plate current flows throughout the entire cycle in this mode of operation.

The tube may also be biased at point B. This is known as cutoff bias since plate current is zero with no signal. It is obvious that the plate current will flow only for one-half cycle. Therefore, in audio-frequency amplification, it will be necessary to use another tube to carry the plate current during the second half of the cycle. This is known as Class B operation. The degree of fidelity is below that of Class A; the efficiency, however, is greater, since no plate current flows until a signal is applied.

A third method of operation, known as Class C, is used in radio-frequency amplifiers where the grid may be biased anywhere from one and one-half to four times cutoff bias. Plate current will flow for only a small portion of the cycle during which time the LC tank circuit is energized.

If cutoff bias occurs in a circuit which is normally biased above this

[Continued on page 46]



CRYSTAL PRODUCTS COMPANY

1519 MCGEE STREET

KANSAS CITY, MO.

*Producers of
Approved
Precision Crystals
for Radio
Frequency Control*



THRU Hell AND High Water!



"War is Hell"—tough on men and equipment. Today, with radio fighting on five fronts, transformers are exposed to every conceivable climatic condition.


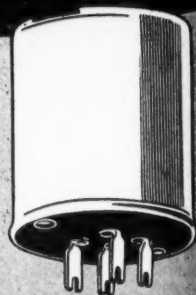
Thermador Transformers are Thermatite treated to withstand extreme temperatures and humidity—arid or moist heat—dry or damp cold do not hamper their efficiency. Thermatite is the name of a process of accurate heat controlled vacuum impregnation developed and improved by ten years of daily use by the same personnel and supervision.

Experienced engineers are at your service at Thermador. May we be of assistance in engineering and producing transformers to meet your requirements?

THEMADOR TRANSFORMER LINE
THERMATITE TREATED

THE THEMADOR TRANSFORMER LINE

Included in the Thermador Transformer line are audio, auto, geophysical, bias supply, bridging, cathode modulation, coupling, driver, field supply, filament, high fidelity audio, input, midjet plug-in audio, mixing and matching, modulation, output, plate, power (combined plate and filament), television, and tube-to-line transformers. Also manufactured are filters, chokes, and reactors (audio and equalizing).



REPRESENTATIVES—Les Logan, 530 Gough St., San Francisco, Calif. • Verner O. Jensen, 2607 Second Avenue, Seattle, Washington • M. J. Klicpera, P. O. Box 3113, Houston, Texas. • FOREIGN DIVISION: Frazar & Co., 301 Clay Street, San Francisco, Calif.

"Seven Leagues Ahead"
THEMADOR ELECTRICAL MFG. COMPANY

RADIO BIBLIOGRAPHY

F. X. RETTENMEYER

RCA Manufacturing Co., Inc.

7—REMOTE CONTROL, Part 3

IN PREVIOUS ISSUES:

Aviation Radio, May, 1942

Frequency Modulation, June, 1942

Crystallography, July, 1942

Tubes, August, 1942

Amplification, Detection, Sept. 1942

Filters, Sound, Loudspeakers, Oct. 1942

Remote Control, Nov., Dec. 1942

Zur Frage der Übertragungsgeschwindigkeit van Fernschalt-und Rückmeldeeinrichtungen nach dem Wahlverfahren — R. Korberich — *Verband Deutscher Elektrotechniker, Fachberichte*, 1934, page 35.

Operating speed of remote indication and control system.

Interconnection Economies Through Telemeter Totalizing — W. J. Lank — *Electrical World*, Vol. 103, 1934, page 958.

Centralized Remote-Control and Regulation of Modern German Batt Furnace Plant—R. W. P. Leonhardt—*Iron & Steel Industry*, Vol. 7, page 159.

Die Fernmesseleinrichtungen für den Betrieb Elektrischer Anlagen—A. Linker—*Elektrotechnische Zeitschrift*, Vol. 55, 1934, page 857.

Remote measuring equipment for operation of electric equipment.

Selsyn Instruments for Position Systems—T. M. Linville & J. S. Woodward—*Electrical Engineering*, Vol. 53, 1934, page 953.

Telemeter with Pilot Coil Transmitter—L. J. Lunas and H. L. Bernarde—*Electrical Engineering*, Vol. 53, 1934, page 974.

Metropolitan-Vickers Remote-Operated Control Equipments for High-Power Trams—*Metropolitan-Vickers Gaz.*, Vol. 15, 1934, page 130.

Telereglage de la puissance et de la fréquence dans les grands réseaux a haute tension—R. Nierenberger—*Société Française des Electriciens, Bull.*, Vol. 4, 1934, page 999.

Remote control of power and frequency in large h.t. systems.

Improved High-Rate Impulse Telemeter System—C. Oman—*Electrical Journal*, Vol. 31, 1934, page 313.

Contactless Watching Devices (For Smooth Remote Control of Motors, etc.) — N. N. Ostrjakov — *Investiya Elektro-Promishlennosti, Slabovo Toka*, July, 1934, page 58.

Instrumento di Consenso a Maniglia Tipo F.S.—G. Pacetti—*Rivista Tecnica delle Ferrovie Italiane*, Vol. 46, 1934, page 116.

Description of Italian co-acting lever instruments for remote control of railroad signals.

Remote Control on M.-K.-T., *Railway Signalling*, Vol. 27, 1934, page 549.

Remote Control on N.P., *Railway Signalling*, Vol. 27, 1934, page 553.

Remote-Control Replaces Mechanical Interlocking on Canadian Pacific, *Railway Signalling*, Vol. 27, 1934, page 400.

Das Fernbedients Wasserkraftwerk Atrop—K. Schinkler and F. Jagger—*Siemens Zeitschrift*, Vol. 14, 1934, page 234.

Europäische Lastverteileranlagen — M. Schleicher — *Elektrotechnische Zeitschrift*, Vol. 55, 1934, page 1243.

European power system control.

Supervisory Control in Germany and the European Continent—M. Schleicher—*IEE Journal*, Vol. 75, 1934, page 710.

Fernschaltung von Pumpanlagen—M. Seibt—*Gas- und Wasserfach*, Vol. 77, 1934, page 905.

Electric and hydraulic remote control systems used in operation of automatic pumping plants.

Mechanical Remote Control Broadens Automotive Applications of Radio—J. C. Smack—*Automotive Industries*, Vol. 70, 1934, page 4921.

Die Technik der Fernwirkanlagen—W. Stablein — Berlin, Oldenbourg, 1934, 294 pages.

Extensive bibliography on telemetering and remote control.

Telemetering System Using Over-Biased Triodes, *Electronics*, October, 1934, page 322.

Remote Operation — A. Trenner — *A.E.G. Mitteilungen*, No. 12, 1934, page 380.

Appareillage de Contrôle a Distance du Fonctionnement des Interrupteurs—F. H. Wallenborn — *Revue Generale de l'Electricité*, Vol. 35, 1934, page 757.

Equipment for remote control in performance of circuit breakers.

Remote Control on the Burlington—W. F. Zane—*Railway Signalling*, Vol. 27, 1934, page 25; *Railway Age*, Vol. 96, 1934, page 291.

Load Totalizing in New York—F. Zogbaum—*Electrical Engineering*, Vol. 53, 1934, page 886.

Commande a Distance des Centres Emetteurs Radio Telegraphiques, *Société Independante de T.S.F.*, Publ. No. 3, August, 1933, page 12.

Remote control of radio-telegraph transmitters.

Telemetering With Supervisory Control—G. DeCroce—*Electrical Journal*, Vol. 30, 1933, page 260.

Ein Neues Kompensationsverfahren zur Elektrischen Fernübertragung von Zeigerstellungen — W. Geyger — *Elektrotechnische Zeitschrift*, Vol. 54, 1933, page 1187.

Remote indicators.

Scheiberfernsteuerungen — H. Grunbaum—*Warme*, Vol. 56, 1933, page 95.

Remote control of valves.

Ferndrehzähler auf Grossflugzeugen—E. Horn—*Zeitschrift für Fernmelde-technik*, Vol. 14, 1933, page 138.

Remote tachometers for large airplanes.

Guarding Remote Control Gear Against Earth Faults—G. H. Landie and H. A. McLaughlin — *Electrical World*, Vol. 101, 1933, page 76.

Elektrische Fernsteueranlagen und Regler in Luftungsanlagen — W. Liesegang — *Siemens Zeitschrift*, Vol. 13, 1933, page 42.

Electric remote control equipment and regulators for air-conditioning.

Developments in the Electric Industry During 1932—J. Liston—*General Electric Review*, Vol. 36, 1933, page 71.

Automatic steering control with automatic radio drift correction, for aircraft.

Die Überlagerung Grosserer Hochspannungsnetze Mittels des Telemereg-Systems — W. Z. Megede — *Siemens Zeitschrift*, Vol. 13, 1933, page 165.

Teleneg audio-frequency remote control of meters, switches, etc.

Some Electrical Methods of Remote Indication—C. Midworth and G. F. Tagg—*IEE Journal*, Vol. 73, 1933, page 33.

La Telemetria Crepuscolare—F. Montauti—*Rivista Marittima*, Vol. 66, 1933, page 21.

[Continued on page 40]

Pumping Station Controlled from Rim of Grand Canyon, *Universal Engineer*, Vol. 57, May, 1933, page 34.

Distant Control Switch—S. R. Raffan—*Scientific Instruments*, Vol. 10, 1933, page 23.

Rectox Unit Saves Extra Control Circuit, *Electrical World*, Vol. 101, 1933, page 515.

Remote Control of Switch Replaces Interlocking, *Railway Signalling*, Vol. 26, 1933, page 161.

Remote Control on Missouri Pacific, *Railway Signalling*, Vol. 26, 1933, page 293.

Remote Control on Soo Line, *Railway Signalling*, Vol. 26, 1933, page 155.

Remote Control Replaces Interlocking, *Railway Signalling*, Vol. 26, 1933, page 243.

Remote Control Replaces Interlocking on Jersey Central, *Railway Signalling*, Vol. 26, 1933, page 195.

Remotely Controlled Rectifier Substation, *Electrical Review*, Vol. 112, 1933, page 240.

Remote Control Replaces Interlocking on Wabash, *Railway Age*, Vol. 94, 1933, page 633.

Rate and Quantity Records Transmitted Over Telephone Circuits—C. S. Richardson—*Power*, Vol. 77, 1933, page 304.

Dankende Fernbedienungseinrichtungen—M. Schleicher—*Siemens Zeitschrift*, Vol. 13, 1933, page 88.

Vario-automatic remote control equipment.

Grundsätze der Fernbedienungstechnik in Stakstromanlagen—M. Schleicher—*Zeitschrift für Fernmeldetechnik*, Vol. 14, 1933, page 81.

Fundamentals of remote-control technique in power installations.

La Jonction Electrique "Siemens" et ses Applications Aux Telecommandes—A. Sornin—*Revue Generale de l'Electricite*, Vol. 33, 1933, page 641.

Remote-Control "Loop" Substation Reduces Investment—R. M. Stanley—*Electrical World*, Vol. 101, 1933, page 454.

Remote Indication and Control Devices—G. F. Tagg—*Journal of Scientific Instruments*, Vol. 10, 1933, page 65.

Tunnel Operation on N.P. is Remotely Controlled, *Railway Signalling*, Vol. 26, 1933, page 317.

Telemeasure et Telecontrôle—Vassiliere-Arlhac—*Societe Francaise des Electriciens, Bull.*, Series 5, Vol. 3, 1933, page 45.

Synchronous Ties—H. A. Winne—*General Electric Review*, Vol. 36, 1933, page 129.

Various methods of obtaining synchronous speed relations between two or more motor-driven mechanisms.

Die Elektrische Fernmessung im Dienste der Gasfernversorgung—W. Wunsch—*Verein Deutscher Ingenieure, Zeitschrift*, Vol. 77, 1933, page 658.

Electric remote measurements in long-distance gas-distribution system.

Stromberg Carlston "patented" Thermostatic Oscillator and Distortionless Remote Volume Control, *Talking Machine & Radio*, September 27, 1933, page 14.

Telemetering, Supervisory Control and Associated Communication Circuits, *Journal AIEE*, Vol. 51, 1932, page 613.

Surveillance a Distance des Positions des Appareils de Compure—T. Bermann—*Electricien*, Vol. 63, 1932, page 490.

Centralized Remote-Control and Regulation in Blast-Furnace Plant, *Iron and Coal Trades Review*, Vol. 125, 1932, page 338.

Transmission de Signaux et Manoeuvres a Distance sur les Lignes Electriques de Transport de Distribution—Chirol—*Congres International d'Electricite, Comptes Rendus*, Vol. 13, Section 12, 1932, page 357.

Use of Telephone Facilities for Telemetering—J. L. Clark—*Electrical News*, Vol. 41, May 15, 1932, page 33.

Remote Control with C.T.C. Equipment on Boston & Albany—J. W. Curran—*Railway Signalling*, Vol. 25, 1932, page 293.

Der Selbsttätige und Ferngesteuerte Betrieb von Wasserwerke—Dittmer—*Gas- und Wasserfach*, Vol. 75, 1932, page 901.

Dei Fernmeldung und Fernregistrierung von Schaltvorgängen—W. Gelinek and H. Kunow—*Siemens Zeitschrift*, Vol. 12, 1932, page 370.

Fernmessung mit Ringeisen-Quotenmessern—W. Geyger—*Archiv für Elektrotechnik*, Vol. 26, 1932, page 535.

Remote metering with iron-ring quotient meters.

Remote Control of Stop Valves—H. Gruenbaum—*Engineering Progress*, Vol. 13, 1932, page 249.

Printing Telegraph Systems and Mechanism (book)—H. H. Harrison—page 1 to 23—Codes, etc.; page 24 to 276—Mechanism; page 277 to 339—Time Division Distributors; page 339 to 345—Filters (Tone Multiplex); page 345 to end—Miscellaneous.

Remote Control of Broadcast Programs—G. W. Haug—*Radio Engineer*, Vol. 12, June, 1932, page 23.

Remote Control of Weighing Appli-

ances—A. B. Jacobus—*Scale Journal*, Vol. 18, July, 1932, page 5.

Torque Balance Telemeter—A. J. Johnston—*Journal AIEE*, Vol. 51, 1932, page 1027.

Augaben der Fernmessung—G. Keinath—*Archiv für Technische Messen*, Vol. 1, 1932, page T5.

Die Fernbedienungsanlage der Kraftwerke Oberhasli—K. Keller—*Siemens Zeitschrift*, Vol. 12, 1932, page 85.

Electrical Telemetering—H. Olken—*Instruments*, Vol. 5, 1932, page 66.

Operation of Long-Distance Points by Hand-Generated Power, *Railway Engineer*, Vol. 53, 1932, page 33.

Appareils et Dispositifs Utilises Pour Rea iser le Telepointage et la Telecommande a Bord des Vanires de Guerre—J. S. Routin—*Congres International d'Electricite, Comptes Rendus*, Vol. 13, Sec. 12, 1932, page 23.

Apparatus and equipment used in remote control on board warships.

Distant Control—N.F.T. Saunders—*Electrical Review*, Vol. 13, 1932, page 350.

Die Abstimmkurve an Elektrischen Fernsteuerungselementen—R. Schadow—*Hochfrequenztechnik und Elektroskistik*, Vol. 40, 1932, page 129.

Tuning curves of electric remote-control elements.

Die Elektrische Fernüberwachung und Fernbedienung für Starkstromanlagen und Kraftbetriebe (book)—M. Schleicher—Berlin, Springer, 1932, 238 pages.

Simplified Remote-Control Interlocking on Missouri Pacific, *Railway Signalling*, Vol. 25, 1932, page 207.

A Remote Control Tuning Unit—Bishop—*Radio Engineering*, August, 1930, page 31.

Remote Control Et Commande Electrique a Distance dans les Reseaux de Distribution et de Transport D'Energie Electrique—Vassiliere-Arlhac, Jr., and Nierenberger, R.—*Societe Francaise des Electriciens, Bull.*, Series 5, Vol. 2, page 460, 1932.

A Remote Control Tuning Unit—Bishop—*Radio Engineering*, August, 1930, page 31.

Remote Control—Lee de Forest—*Radio News*, September, 1930, Page 215.

Turning radio off by shining a flashlight on selenium cell. Slow operating relay turns set on again after a time interval.

An Electron Tube Telemetering System—A. E. Fitzgerald—Presented at the summer convention of the AIEE, Toronto, Ontario, Canada, June, 1930. Kinematic Remote Control, *Radio Broadcast*, January, 1930.

[Continued on page 42]

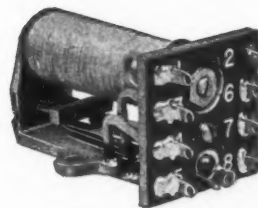
FROM SIGNAL LIGHTS TO SIGNAL CORPS



RELAYS BY GUARDIAN

★Where formerly "Relays by Guardian" were used in such peacetime applications as signal lights . . . all "Relays by Guardian" have now gone to war. For example, the BK-10 relay handles two-way radio communication in several types of "Walkie-Talkie" units.

It facilitates switching over from "send" to "receive." Built for operation at 12 volts, the BK-10 relay makes and breaks contacts firmly when the potential is reduced to 9 volts. Contact combination is made up of two stacks, one being single pole, double throw—the other 1 make, 1 break. Contact points are highly tarnish resistant sixteenth-inch palladium. The compact, light weight BK-10 relay weighs four ounces and measures $3\frac{1}{8}$ " x $1\frac{1}{2}$ " x $1\frac{3}{8}$ ". It is built to U. S. Army Signal Corps specifications.



Series BK-10 Relay

Planning for today or post-war? Send for Bulletin 195 describing this and other "Relays by Guardian" used in aircraft, ground and mobile communications.

GUARDIAN ELECTRIC

1605 WEST WALNUT STREET CHICAGO, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN WAR INDUSTRY

RADIO

★ JANUARY, 1943

RADIO BIBLIOGRAPHY

Flexible Shaft Control for Aircraft Receivers—Robert S. Kruse—*Electronics*, October, 1930, page 366.

Lyric 24-Hour Tuning, *Wireless World*, October 29, 1930.

Robot Tunes Receiver, *The New York Sun*, April 26, 1930.

Take your Choice of Remote Control, *Radio News*, January, 1930, page 623. Three Transmitters and One Serial, *Science and Invention*, December, 1929.

A Simple Remote Control Device, *Radio News*, July, 1928, page 48.

A Unique "No Dial Receiver," *Radio News*, December, 1928, page 556.

Automatic Tuning for the Radio Receiver, *Radio Broadcast*, June, 1928, page 72.

An Automatic Radio Receiver—Best—*Radio*, June, 1928, page 12.

Several Outlets for Control Suggests Detuning for Volume Control—Rowe—*Radio News*, February, 1938, page 893.

A Time Switch for the Receiver, *Radio News*, November, 1927.

Push-Button Radio, *Popular Mechanics*, February, 1926, page 242.

A Push-Button Radio, *Radio News*, August, 1925, page 178.

PATENTS

#2,103,079—1934-37—Johnson (Hazel-tine)—Remote control by cable.

#2,098,331 — 1934-37 — Bowman — Automatic station selector for radio receivers.

#2,087,222—1929—La Via—Time preselecting tuning.

#2,062,259 — 1930 — Thomas (RCA) — Remote Control Device for Receivers.

#2,061,736 — 1932 — McLennan — A superheterodyne receiver with remote speaker. Uses cables.

#2,048,772 — 1935-36 — Bauer — Remote tuning system for radio receivers. Uses b.f.o.

#2,045,251 — 1931 — Reber — Time control; preselecting; motor tuning.

#2,044,927—1933 — Halstead W. West — Remote control for radio receivers. Uses semi-variables.

#2,042,956 — 1930-36 — Nelson — Radio tuning device.

#2,037,383—1930—Koch—Remote control using multivibrator and variable resistors.

#2,031,555 — 1931-36 — Blatterman — System for remotely controlling a radio receiver, over power lines.

#2,003,877 — 1930-35 — Blatterman — Remote control system for radio broadcast receivers, over power lines.

#2,002,541 — 1933-35 — Mallory — Remote control of electrical devices. Uses carrier current over power lines.

#1,992,599 — 1931 — Bellamy — Remote preselection—gang condenser.

#1,992,326—1930-35—Powell (Stromberg Carlson)—Remotely controlled radio receiving system, motor tuning.

#1,983,759 — 1926-34 — Houston — Time tape control. Uses punched tape to distribute programs.

#1,956,419 — 1930 — Garret (G.E.) — Clock control.

#1,946,743 — 1927-34 — Hollerith — Remote control of tuning stages simultaneously operable.

#1,941,627 — 1932-34 — Schramm (A.T.&T.)—Remote control system. Uses a plurality of wires and thyatron-driven motor.

#1,929,928 — 1925-33 — Mittell (RCA) — Sound reproducing system. Covers push buttons that indicate the last one pushed and remote control of volume and tone.

#1,928,200 — 1926-33 — Faas (RCA) — Automatic radio station selector. Uses level arm operated by plug inserted in hole.

#1,917,881 — 1929 — Germanton — Push buttons over L.S. line preselection.

#1,913,482 — 1927-29 — Graham — Muting speaker by end thrust of motor used for tuning.

#1,881,395 — 1927-32 — Mull — Radio reception. A band pass r.f. amplifier rebroadcasting at same frequencies.

#1,881,392 — 1927 — Washington — Remote control and means for turning on and off set.

#1,877,502 — 1929-32 — Flocco — Remote tuning control for radio receivers. Uses air for controls.

#1,871,672 — 1929-30 — Ellinger — Mechanical preselection motor and solenoid control.

#1,994,603 — 1930-35 — Blatterman — Method and means for the optional operations of a radio receiver either by direct or remote control.

#1,856,310 — 1930-32 — Blatterman — Remote control system for radio receivers. Remote control by carrier over the house wires.

#1,856,213—1929-32—Hamilton (A.T.&T.)—Radio receiving apparatus. Push-button tuning, remote volume.

#1,815,045 — 1928 — Boddie — Airplane landing field flood light control.

#1,799,238—1926-31—Lieb (RCA).

#1,772,786 — 1929-30 — Sokoloff — Auto selective attachment for radio tuning. Approximate time operated device for tuning radio on and changing tuning.

#1,760,080 — 1928-30 — Nisenson — Device for controlling radio apparatus. Fixed-tuned circuits cut in relays.

#1,758,570 — 1919 — Gauthier (Federal Tel. & Tel.)—Electrical communication system. Selection system for connecting through remote receivers, etc.

#1,754,326 — 1923-30 — Lieb (RCA) — Broad claims.

#1,751,972 — 1924-30 — Bobroff — Hospital signal system motor-actuated mechanism.

#1,747,863 — 1926 — Dickieson — Remote control of osc. for noise suppressor. Another object—to control operation of osc. generator from a distant point.

#1,735,762 — 1927-29 — Huthmacher — Timing mechanism. Uses alarm clock.

#1,732,688—1923-29—Mallory (Westinghouse)—Combined signal system. A means to operate remote receiver from a transmitter at any time of the day.

#1,709,377—1922-29 (RE-15,924, 1927) — Sperry—Controlling a series of landing lights, etc., from a plane by radio.

#1,697,778 — 1924-29 — Renwick — Remote control unit. Coil and condenser remote from main part of receiver by cable.

#1,695,919 — 1925-28 — Gould — (Zenith)—Tuning device. Uses a slider connected by belt to rotary tuning.

#1,685,835—1925—Bascom (A.T.&T.) — Program selecting.

#1,681,529—1925-28 (RE-18,650-1932.) — Fremont—Radio tuning mechanism.

#1,866,505 — 1927-28 — Peterson — Short or long wave adapter plug in detector socket of receiver.

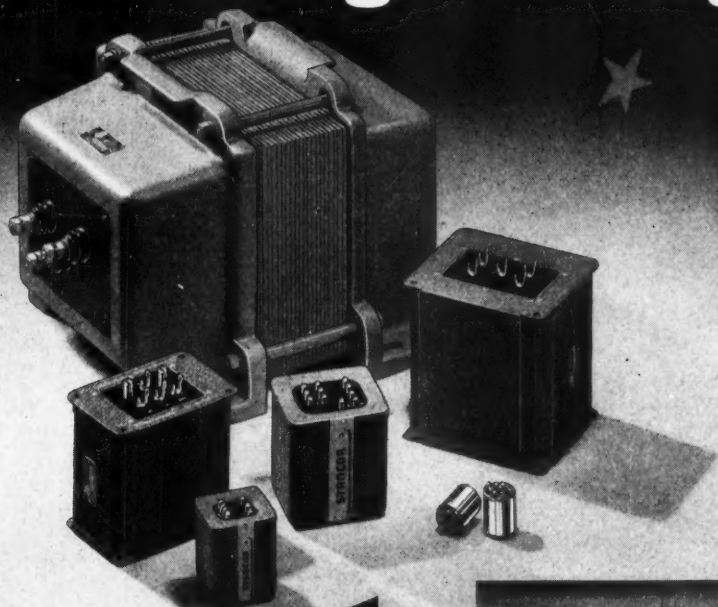
#1,607,485 — 1924-26 — Schmidt — Wireless secret telephone. Voice transmission over variable frequency carrier.

#1,591,417—1925-26—Flocco (Zenith) — Means for controlling and tuning receiver sets from a distance. Motor drive.

#1,658,825 — 1926-28 — Wolf — Radio

[Continued on page 44]

"Get the Message Through!"



"GET THE MESSAGE THROUGH!"—the slogan of the U. S. Signal Corps—typifies the importance of communications in our armed forces.

★★★★STANCOR is geared to the vital necessities of the Signal Corps. Lives depend upon it! Successful operations depend upon it! "Unfailing accuracy" therefore is the STANCOR watchword.

Laboratory research and skillful engineering always have been highly important in the production of STANCOR Transformers. Now, more than ever before, these factors are emphasized in many new fields and in many new uses.

Illustrated above are a few of the many "MADE-TO-ORDER" STANCOR Transformers that are "precision performers." We can assist you in solving your transformer problems and meet your needs in compliance with exacting government specifications. Submit your requirements today.

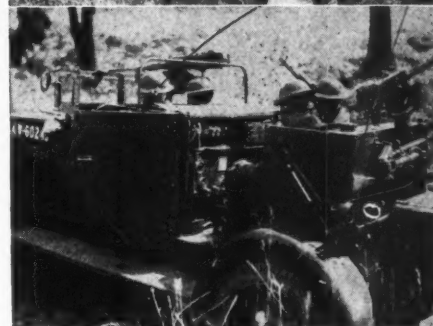
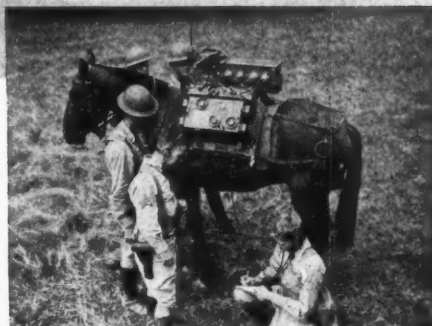


PHOTO BY U. S. SIGNAL CORPS



STANDARD TRANSFORMER • CORPORATION •

1500 NORTH HALSTED STREET • • • CHICAGO

RADIO

★ JANUARY, 1943

RADIO BIBLIOGRAPHY

control. Station system. Uses varying current over speaker lead to cut a speaker into one of a number of circuits.

#1,625,822—1926-27—Potter (A.T.&T.)—Radio receiver and trouble alarm. A means for remotely testing receiver and a means for ringing an alarm if receiver is inoperative.

#1,586,060 — 1922-26 — Bainton — Means for guarding against the unauthorized receiving of radio communications. Frequency changing means.

#1,583,854 — Perry (A.T.&T.) — Wire and radio remote control.

#1,582,695 — 1921-26 — Ronesbaum (Westinghouse) — Radio communication systems. Remotely turning on any one or more of a number of receivers by sending a sequence of impulses. Very broad.

#1,581,368 — 1924-26 — Van Deventer (Dubilier)—Radio control apparatus. Coil control of carrier-current system.

#1,581,145 — 1924-26 (RE-17,002-1928) — Vasselli (Zenith) — Mechanical means for tuning condenser by one movement.

#1,578,551—1921-26—Schwartz (Westinghouse) — Relay arrangement for changing the tuning of wireless apparatus.

#1,562,056 — 1921-25 — Rice (G.E.) —Radio receiving system. Diversity reception; has a detector at each antenna; sends r.f. signal out and produces an audible beat frequency which is sent back over the same lines.

#1,552,919—1919-25—Gauthier (Wired Radio)—Carrier current system, for transmission between fixed or movable stations.

#1,535,189 — 1925 — Thompson — Motor and flexible drive for continuous tuning—compensation means to keep coupling constant.

#1,534,719—1921-25—Kellogg G.E.) — Radio receiving system.

#1,528,032—1921-25—Steage (Westinghouse)—Selective signaling system. Radio frequency changing by clock mechanism—cycle variations.

#1,522,581 — 1922-25 — Espenschied (A.T.&T.) — Radio broadcasting system. A monitoring system to notify at receiving end when carrier goes off.

#1,522,361 — 1924-25 — Clement (assigned to E. F. Colladay)—Broadcast selecting and distributing system.

#1,522,360—361 and RE-17,163—1924-25—Clement—Radio broadcasting selecting and distribution system. Carrier current.

#1,469,349 — 1921-23 — Wilson (Westinghouse)—Radio control system. Uses keyed carrier and a number of radio frequencies to operate a coded device similar to a Gill selector.

#1,456,614 — 1921-23 — Behlen — Automatic record transferring mechanism for phonographs.

#1,447,773 — 1921-23 — Espenschied (A.T.&T.)—Radio transmission control system. Uses a separate channel frequency on carrier to vary the received signal audio level to keep it constant.

#1,399,254 — 1917-21 — Hammond — System of radiodynamic control. Radio control for torpedo, etc.

#1,314,593 — 1915-19 — Hewitt — Directive wireless transmission. Includes claim on repeating radio signals automatically.

#1,228,963 — 1912-17 — Peepelkin — Motor and switch, etc., for control at a distance.

#1,099,865 — 1912-14 — Stelmaker — Hoff.—A signal hunting tuner with automatic stop and alarm.

#368,229 — 1929 — Kolster (Br.) — Improvements relating to h.f. receiving systems. A pull cable remote control.

#358,213 — 1930-31 — Kolster-Brandes (Br.) — Improvements relating to broadcast receiving apparatus. Continuous tuning by push-button, with a number of remote stations taking control at will.

#292,095 — Helling — Aug. 13, 1929, Filed May 19, 1928. (Canada)—Automatic tuning control mechanism for radio apparatus. Push button tuning with motor.

#289,163 — 1927-28 — Wilbourne (Br.) — Improvements in or relating to remote control mechanism for indicating and other purposes. Novel use of flexible shafts.

#289,162 — 1928 — Barber. (Br.) — Remote control mechanism. Uses turn cable.

#263,567 — 1925 — Holt (Br.) — Bowden cable to tune.

#248,821 — Mittell (Br.) — Relays at volume control point for turning set on or off.

#243,041 — 1924-25 — Barber (Br.) — Remote control mechanism. Novel use of flexible shafts.

#238,338 — 1924 — (Br.) — Uses preselected tuned circuits with relay to change from one to another.

#2,122,912 — 1925-38—Levy (Federal Tel. & Tel.) — Automatic Tuning. Broad on remote of volume-tuning.

#1,970,064 — 1930-34 — Thronley — Remote volume control for sound picture equipment. Ratchet relay operating by impulses and push buttons.

#1,968,973 — 1927-34 — R. E. Thompson — Broad on remote control of stages individually but simultaneously operable. Ratchet tuning.

#1,942,587 — 1930-34 — Whitman (Hazeltine Corp.) — Control system. An a.c. balanced bridge, the unbalance being amplified and applied to thyatron grids in parallel. Plates supplied by a.c. 180° out of phase to operate one of two motor drive relays.

#1,932,925 — 1931-35 — Chauvean (Fr.) — Automatic radioelectric standby device. A hunting system automatically stopped by receiving signal but started again unless a predetermined signal is received within a predetermined time.

#1,932,816 — 1929-33 — Gargan (Bell Tel.) — Remote control device. A geared remote control unit operating through a flexible shaft.

#1,930,209 — 1927-33 — Alden (Radio Inventions) — Continuous tuning or step by step. Uses two tones or frequencies.

#1,926,383 — 1930-33 — Manson (Stromberg) — Remote control radio receiving system. Preselection and continuous.

#1,926,256 — 1931-33 — Barrett (Utah) — Remote control device for radio receiving system. Pull cable device.

#1,863,931 — 1930-32 — Miller — Selective control mechanism for radio sets. Clock timing and solenoids with racks and gears to turn dial.

#1,808,916 — 1925-31 — Burkholder (W.E.)—Circuit control system. A ratchet step means for tuning receiver. Uses solenoids to determine direction.

#1,796,998 — 1928-31 — Hand — Remote control and indication of a loop.

#1,780,669 — 1925-30 — Bruckel — A remote telemetering system by varying the frequency of a carrier current, using a tuned circuit (series) driving one tube across the capacitor and the other across the inductance.

#1,778,761 — 1924-30 — Heising (W.E.) — Remote control system. Uses step by step motor.

#1,769,256 — 1927-30 — Clark — Plug-in remote volume control.

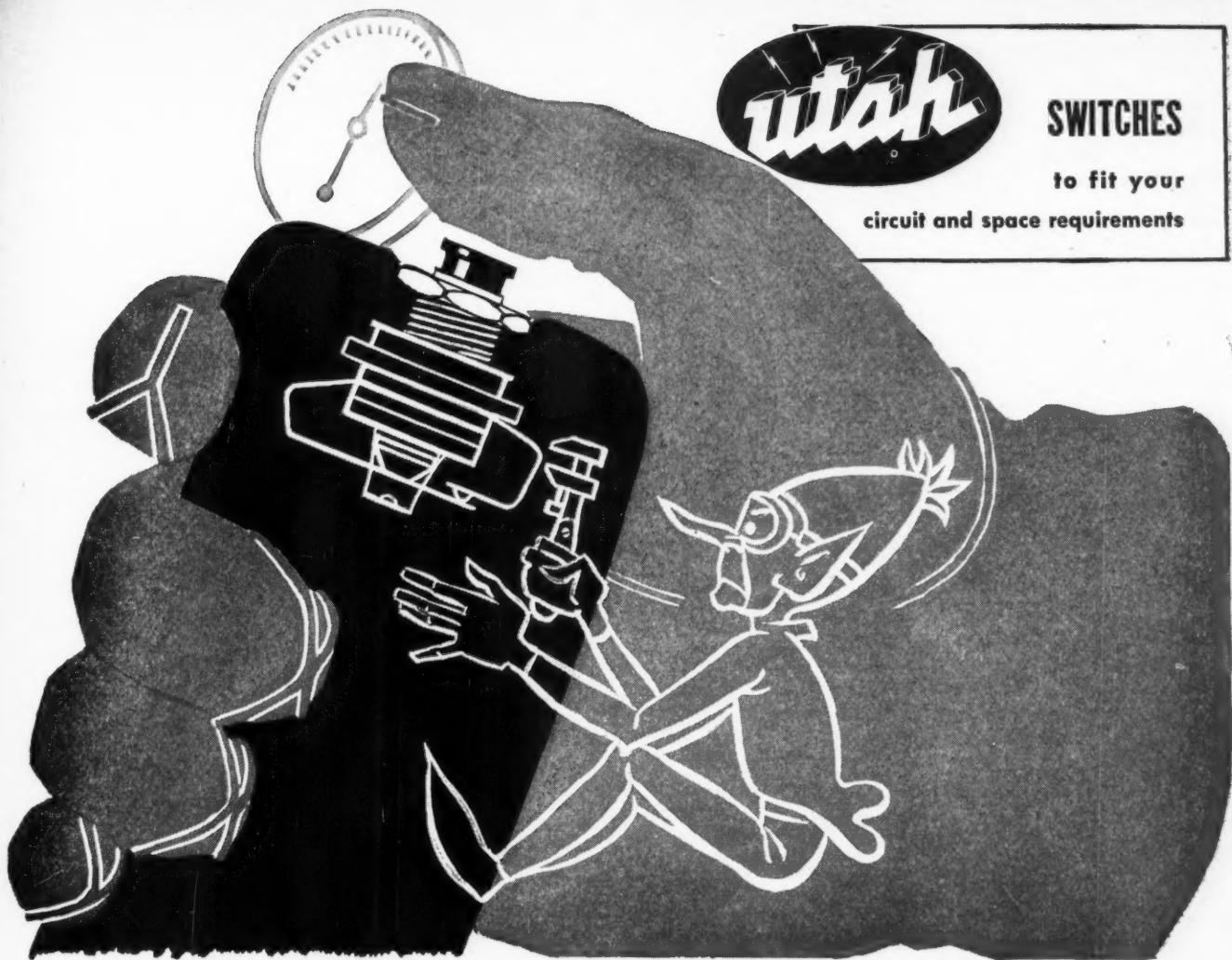
#1,742,147 — 1926-29 — Renwick — Distant control for radio apparatus. Motor control of tuning with voltmeter indicator at remote end. Uses brake on motor.

[Continued on page 46]



SWITCHES

to fit your
circuit and space requirements



NOTHING TO A GREMLIN— *with dependable Utah Switches*

THOSE mischief-making, invisible little creatures, known among the RAF as Gremlins, can't stir up trouble where Utah Switches are concerned. Like other Utah-Carter parts, Utah Switches are built to give dependable performance—and have proved themselves in hundreds of electrical operations.

Compact size, highest quality and economical price are combined in Utah "Imp" push-button switches. They have the finest nickel silver or phosphorous

bronze springs with integral contacts. Springs are fully insulated in the mounting, bushing and shaft—have high grade phenolic insulation. They are available in three circuit arrangements: "Single-Make"—"Single-Break"—one "Break-Make."

Also available are Utah-Carter Rotary and Push-Button Jack switches, in long and short types. Small and compact in size, they are made to take minimum panel size. Full insulation is provided for all electrical parts. Write today for full details.

UTAH VITREOUS ENAMEL RESISTORS—from 5 to 200 watts, they are available either as fixed—tapped or adjustable. Also non-inductive types.

UTAH JACKS—long and short frame and "Imp" type jacks to meet your requirements. Special Utah jacks to meet Navy and Signal Corps specifications.

UTAH PHONE PLUGS—two or three conductor types—for practically every type of application.

UTAH TRANSFORMERS are fully guaranteed. Able to meet the requirements in choke, input, output and smaller capacity power transformers.

UTAH RADIO PRODUCTS COMPANY

General Offices and Factory

846 ORLEANS STREET



CHICAGO, ILLINOIS

RADIO BIBLIOGRAPHY

#1,738,262 — 1925-29 — Powell (Stromberg Carlson)—Method and apparatus for remotely controlling radio receiving systems. Uses bridge unbalance and motor tuning. Two wire control.

#1,718,497 — 1924-29 — St. Clair (G.E.) —Telemetric system. Remote control metering by variable frequency.

#1,706,968 — 1929 — Schlekher — Apparatus for control of movable member. Uses Wheatstone bridge.

#1,655,160 — 1922. Reissued #18,637 — 1932. Powell (Stromberg Carlson) — Radio selected and continuously tuned over telephone line. Audio fed back over same wires. Broad.

#1,626,449 — 1925-27 — Brown (G.E.) — Automatic antenna regulation. A means for retuning antenna when it is tuned above or below a master tuned circuit.

#1,600,204 — 1924-26 — Alexander-son (G.E.) — Means for transmitting angular motion. Operations of selsyn motors over radio circuit. Translates current flowing in each armature leg into impulses of different lengths. Impulses transmitted over three carriers.

#1,587,924 — 1921-26 — Round (RCA) — Wireless signaling system. Automatic tuning means that tends to keep a circuit tuned to a given frequency.

#1,586,233 — 1925-26 — Anschutz Kaempfe — Means for controlling rotating field motors. Uses an a.c. bridge to change the phase and direction of current in the second field winding of an induction motor.

#1,563,994 — 1921-25 — Kaminski (Siemens Halske) — System for adjusting devices at a distance. A system for rudder control, etc., that uses selsyn motors for indication.

#1,428,507 — 1922 — RE 15,924 — Sperry — Wireless repeating system. Uses control by sending three r.f. signals in sequence to operate step by step motor.

#1,296,440 — 1911-19 — Sperry — Repeater system for gyro-compasses. A step by step motor. Uses contacts that overlap to give greater number of steps per revolution.

#1,234,127 — 1915-17 — Bristol (Bristol Co.)—Automatically synchronized entertainment device. Selsyn principle.

#1,052,528 — 1910-13 — Sundh (Otis Elevator) — Inductive controlling apparatus. Uses an induction bridge

unbalance to remotely control indicators, etc.

#811,539 — 1905-06 — Bates (Westinghouse) — Electric control system. For electric motors, by means of which the amount and direction of movement of the operated device may be accurately predetermined and governed.

#707,056 — 1/10/02 — Ehret — Auto selective system. A motor driven collator switch, a number of fixed tuned circuits, and means for stopping collator switch when it is connected to an energized tuned circuit.

#459,323 — 1890-91 — Weuste — Electric contact apparatus. Uses double ratchet for remote indication.

#406,830 — 1888-89 — Fiske — Method of finding range and position of distant objects. Wheatstone bridge. #354,124 — 1930-31 — Kolster-Brandes — Improvements relating to remote control devices for radio receivers. Wheatstone Bridge with motor drive for tuning. Voltmeter indicator at remote point.

#341,464 — 1929-31 — Crilly (Canada) — Improvements in or related to control systems for radio instruments. Pre-selection, motor drive, remote volume control.

#287,191 — 1915 — Ratchet tuning of a variable condenser.

Q. & A. STUDY GUIDE

[Continued from page 36]

point, the condition is referred to as a blocked grid. This technique is used advantageously to intermittently suppress operation in some continuous-wave (c.w.) transmitters.

27. What is meant by the load on a vacuum tube? (II-142).

28. What is meant by the term 'maximum plate dissipation'? (II-140).

29. Draw a simple longitudinal cross-section of a water-cooled transmitting triode, showing the internal structure and labeling the various elements. (IV-110).

30. A 50-kilowatt transmitter employs 6 tubes in push-pull parallel in the final Class B linear stage, operating with a 50-kilowatt output and an efficiency of 33%. Assuming that all of the heat radiation is to the water-cooling system, what amount of power must be dissipated from each tube? (IV-126).

Audio amplifiers must transmit a wide band of frequencies, all with the same amplitude. Therefore the load in

the plate circuit of the tube must be an untuned, i.e., non-resonant, impedance. In all modes of operation this load is effectively a pure resistance in the middle frequency range. In radio-fre-

quency amplifiers the load is usually a tuned circuit.

As mentioned before, the plate of a vacuum tube functions as a collector of electrons. These electrons bombard the plate at very high velocities and their energy is liberated in the form of heat. When a tube is operating with a signal on the grid, part of the d-c power supplied to the plate circuit is converted into useful a-c power (audio- or radio-frequency). The remainder is dissipated in heat. With no signal applied to the grid and a bias above cutoff, all the power ($E_p I_p$) supplied to the plate circuit is dissipated in heating the plate. Each tube has a safe maximum plate dissipation which depends upon its construction. Referring to Question 30, the d-c power input is approximately 150 kilowatts. 50 kilowatts is useful output. Therefore, 100 kilowatts are dissipated in heat. Each tube then must dissipate around 16.67 kilowatts in the form of heat. Such large quantities of heat must be removed by circulating distilled water around the anode.

A longitudinal cross-section of such a water-cooled transmitting triode is shown in Fig. 3.

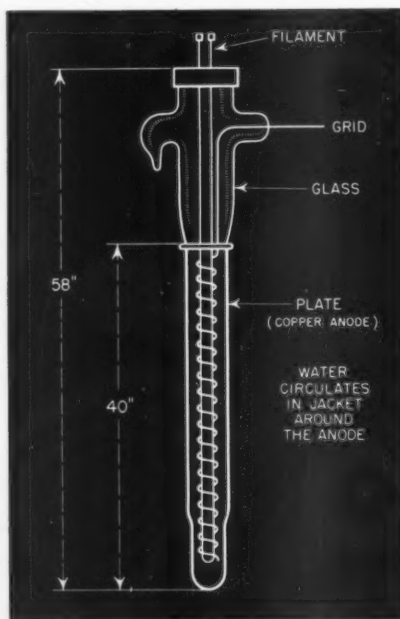
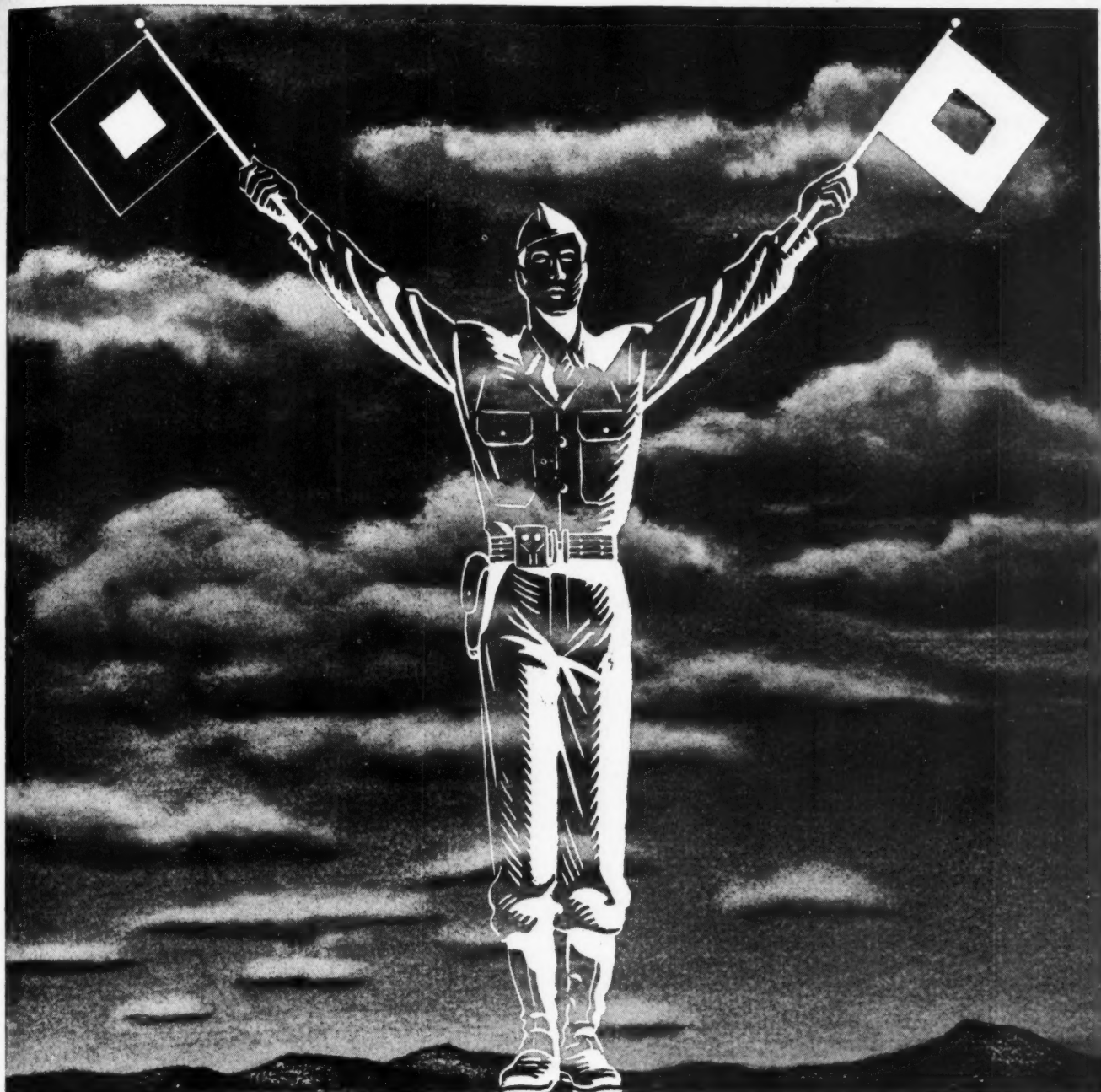


Fig. 3. Water-cooled transmitting triode.



U. S. SIGNAL CORPS! When the smoke of battle fades and historians record the heroic deeds of men and armies —only then will we fully appreciate the important role of the U. S. Signal Corps in this world conflict! Our victories on the field and in the air can be attributed in a great measure to the sacrifice, skill and courage of the men in this branch of the armed services. They are in fact the nerve-center of our fighting forces.

COURTESY OF
JEFFERSON-TRAVIS RADIO MFG. CORP.

NEW YORK, N. Y.

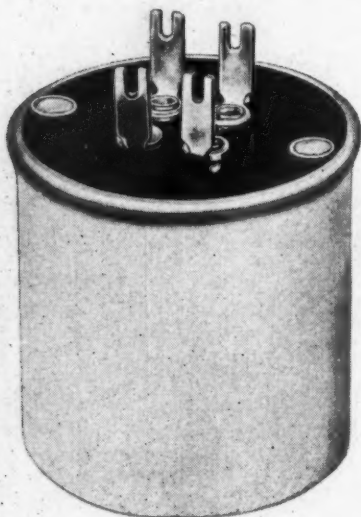


WASHINGTON, D. C.

NEW PRODUCTS

THERMATITE TREATED TRANSFORMERS

Thermatite treated transformers, which constantly withstand extreme conditions of humidity and heat have been announced by the Thermador Electrical Manufacturing Company, of Los Angeles.

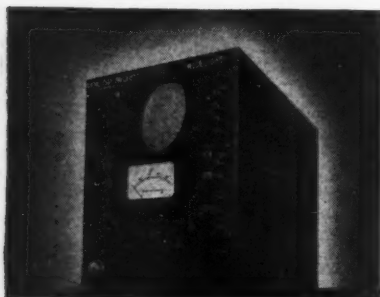


Now that radios and radio equipment often go into territories with extreme weather conditions, this new tested and approved form of impregnation is very important. Thermador manufactures Thermatite treated transformers in smaller sizes for radio use.

★

R.C.P. CATHODE-RAY OSCILLOSCOPE

Radio City Products Company, Inc., announces its new Cathode Ray Oscilloscope Model 555. This instrument uses a 5" cathode-ray tube operating on 2,000 volts. Maximum d.c. voltage at input to amplifier is 600 v. and direct to deflection plates 500 volts, rms. In-



put resistance is 3 megohms. Frequency response is ± 3 db from 20 cycles to 2 megacycles. Voltage gain is approximately 275 times. Ultra wide frequency range of sweep signal generator from 30 cycles to 350 kc, linear from 50 cycles. Unknown peak input voltage can be read on a direct indicating multi-range voltmeter. This is accomplished by a unique comparison method with an internal voltage source. Instrument operates from standard 115-230 volt, 50-60 cycle ac power supply.

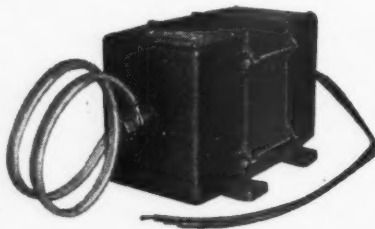
Model 555 is housed in a black crackle, non-corrosive, steel case, 14" high, 12" wide, and 19" deep with convenient carrying handle.

★

ISOLATING TEST TRANSFORMER

Testing of radio and communication equipment, especially for Signal Corps or other Service Branch use requires special accuracy. The usual practice is to test such equipment within a shielded test-room but even under such circumstances radio interference can enter shielded test-rooms by means of the power line.

To eliminate all interference that would affect the testing of equipment whose performance depends upon accuracy, the engineering department of The Acme Electric & Mfg. Co. of Cuba, New York, have designed the



Acme Type T-4173 Isolating Transformer. This transformer makes use of a secondary completely enclosed in a copper shield. Secondary terminal connections are provided by means of a lead shielded cable, the sheath of which is integrally joined to the copper enclosing shield of the secondary winding.

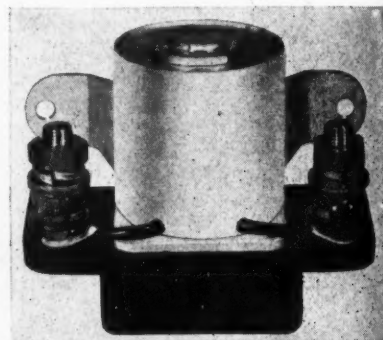
The manufacturer claims that the Isolating Transformer, normally rated at 2 kva is capable of handling an overload of 50% or a total load of 3 kva. The regulation of the transformer

is 1% at 1 kva. The lighting in the shielded test-room, the use of soldering irons, instruments and various types of test equipment may all be operated from the shielded secondary of the Isolating Transformer without causing objectionable voltage drop. The use of instruments or equipment may be used as the need requires, the load being switched on and off without affecting the relatively constant voltage necessary for accurate testing.

★

AIRCRAFT SOLENOID CONTACTOR

Guardian Electric announces production of five types of approved solenoid contactor units built to U. S. Army Air Force specifications, for remote control of electrically actuated



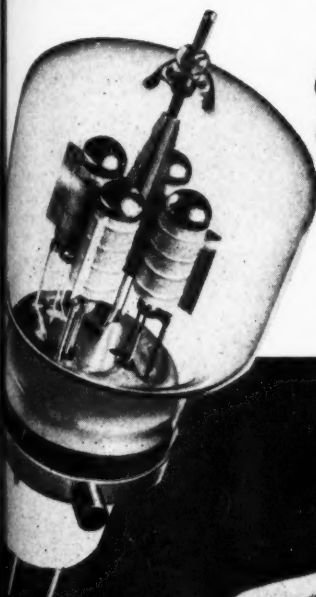
aircraft armaments, instruments and devices. Among these, the B-4 type illustrated, originally designed for airplane starting motors, may be used for other applications of heavy current control.

The B-4 Solenoid Contactor operates on 24 volts, producing a coil current of 300 milliamperes. Contacts are rated at 200 amperes at 24 volts d.c. Unit has double pole, single throw, normally open contacts. It is claimed that unit resists acceleration and vibration over 10 times gravity and operates in any position. May be disassembled with pliers and screwdriver. Metal parts are plated to withstand 200-hour salt spray test. Weight of unit, 31 ounces. Descriptive circular and full details available from Guardian Electric, Dept. B-4, 1605 West Walnut Street, Chicago, Illinois.

[Continued on page 64]

A date with Destiny

These two modern weapons of battle...the electronic tube and the bombing plane... have an important date with post-war industry. In the days to come Eimac tubes, like the airplane, will help achieve the better way of life for the common man.



Eimac
TUBES

"First in Peace, First in War," First in the important new developments in the field of electronics.

OFFICIAL PHOTO U. S. NAVY



For high achievement in the production of war material... the joint Army-Navy "E" awarded September 4, 1942.

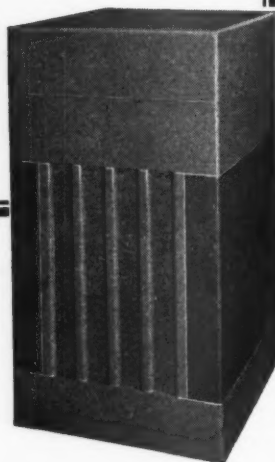


EITEL-McCULLOUGH, INC.
SAN BRUNO • CALIFORNIA • U. S. A.

Export Agents: FRAZAR & CO., LTD.
201 Front Street, San Francisco, California, U. S. A.



Sell A Presto Recorder with your War Plant Sound Systems



ALL WAR PLANTS wired for sound want to broadcast radio programs, company announcements, news items, messages to workers from company officials.

Often these messages must be repeated to three shifts of workers and to various plant divisions.

A Presto recording will enable one good announcer to record all announcements *once* for these broadcasts. A familiar voice assures clear understanding of all messages.

Include a Presto recorder in your next industrial sound installation. It's extra business for you. It will save operating time and double the usefulness of the system.

You can get prompt deliveries on the Presto Model H 16" recorder and record player. Write for literature.

PRESTO
RECORDING CORP.
242 WEST 55th ST. N.Y.

World's Largest Manufacturers of Instantaneous Sound Recording Equipment and Discs

In Other Cities, Phone . . . ATLANTA, Jack. 4372 • BOSTON, Bel. 4510
CHICAGO, Har. 4240 • CLEVELAND, Me. 1565 • DALLAS, 37093 • DENVER,
Ch. 4277 • DETROIT, Univ. 1-0180 • HOLLYWOOD, Hil. 9133 • KANSAS
CITY, Vic. 4631 • MINNEAPOLIS, Atlantic 4216 • MONTREAL, Mar. 6368
TORONTO, Hud. 0333 • PHILADELPHIA, Penny. 0542 • ROCHESTER,
Cul. 5548 • SAN FRANCISCO, Su. 8854 • SEATTLE, Sen. 2560
WASHINGTON, D. C., Shep. 4003

RADIO AVIGATION

[Continued from page 22]

sky waves are definitely limited in range.

There are no fixed rules for taking into consideration the night effect. Only experience can teach an operator to recognize all the forms of night effect. Care in taking a bearing and closely watching the minimum over an interval of time will help eliminate false readings. An ADF should "hunt"; that is, vary slightly on each side of the true reading, on a good bearing. Experience is the only teacher in detecting night effect in all cases.

DF Procedure

Understanding the errors which are likely to interfere with good bearings reduces the procedure to straightforward DF work in flight. When navigating in normal flight the number of bearings will depend upon the stations available and necessity. A minimum reading is obtained and in the case of a broad split, maximum and minimum readings are noted and the mean reading taken.

At the same time the bearing is taken, or as soon as possible thereafter, the compass heading is noted. A correction curve will almost invariably be found for both the DF and the ship's compass². For the compass, error is usually indicated as East or West, to obtain corrected compass reading. Easterly corrections are added and westerly corrections subtracted. DF corrections are generally indicated as positive or negative error, as in Fig. 2. The corrected bearing and corrected compass heading are added; should their sum equal more than 360°, this amount is subtracted. The result is the magnetic heading of the ship. The magnetic variation, observed from charts, in which the approximate location of the plane is known, is then added or subtracted, based on the rule that easterly variations are added and westerly variations subtracted to obtain the true bearing.

²Not discussed as a radio error, but nevertheless a controlling factor in accurate DF work, is the handling of the plane by the pilot, and reading of the compass. The airplane must be held on a constant course and at a level altitude. Serious "yawing" or turbulence make bearings inaccurate and impractical. In reading the compass to obtain the ship's heading, care must be exercised to make sure there is no compass lag. This is best determined by making sure the reading remains constant for a minimum of 20 seconds preceding the bearing.

[Continued on page 52]



*"Still Doing Business
at the Same Old Stands"*



SERVICEMEN

... your Distributor can
STILL Supply you with

Centralab

MIDGET RADIOHM REPLACEMENTS

Fortunately . . . your distributor
can still supply you with Midget
Radiohms for replacements.

The smooth wall-type resistor for
which Centralab Radiohms are
famous will keep that now-precious
radio in good working condition.

Stick to OLD MAN CENTRALAB
for Replacements . . . and always
specify "CENTRALAB".

RADIOHMS • FIXED RESISTORS
• FIXED AND VARIABLE
CERAMIC CAPACITORS
• SELECTOR SWITCHES

CENTRALAB: Div. of Globe-Union Inc., Milwaukee, Wis.

Since the position of the plane is not known on the operator's chart, it is impossible to plot the bearing without first taking the reciprocal (Bearing plus or minus 180° , depending upon its value; if bearing is less than 180° add 180° , over 180° subtract 180°). The reciprocal bearing must be plotted from the station. Bearings may be used to indicate the track of the plane, as a means of calculating the speed, or to locate the plane's position in a DF fix in Fig. 3.

As a check on speed, bearings which cross the track are taken at intervals. The time between the bearings and

their point of intersection with the track is recorded and from this data the speed is readily determined. This procedure may be repeated several times to give an accurate check.

When a plane is reasonably close to the DF station the pilot may start to "home in." If an ADF is used, an "on course" relative bearing of 0° is flown, assuming no wind drift. Allowance for wind drift, if its velocity is over several knots, should be made. If only a loop is available, it may be locked in the zero position and the same procedure followed.

It is satisfactory in most cases, par-

ticularly involving the manual loop, to take bearings at frequent intervals, say around every 10 minutes. Right drift is subtracted and left drift added to the compass course. By neglecting drift the plane will home in on a parabolic course.

Instrument Let-Downs

A number of types of instrument approaches exist, all of which are based on either relative bearings taken directly from the DF or QDM's, the magnetic bearing (Relative bearing plus compass heading equals magnetic bearing.) Approaches follow a definite sequence in which a certain bearing is flown for an allotted time, the course changed, again a bearing is flown for an allotted time, and the process repeated until the plane breaks through the overcast. The approach is entirely predicated on speed, time, and course from the instant the plane passes some given point; an abeam reading of 90° or 270° , or an overhead on the station, which is indicated by lack of aural minimum. Instrument approaches may also be made by boxing a station, which gives the exact position of the plane by a series of 90° turns around the signal source. Completely blind landings, except in the case of seaplanes which, because of larger landing areas are more easily handled, necessitate special equipment.

As in the case of fan-markers or the radio range apparatus, the equipment is in the hands of the pilot and as such is not a function of the radio navigator.

Should a plane be lost, or an operator unable to determine whether a station is 180° in error with his bearing, an "on course" or 90° or 270° should be flown, holding it until the observed bearing changes noticeably. If the bearing increases, the station is on the right; if it decreases, the station is on the left.

When bearings are being taken on an airplane from a ground station, whenever possible a trailing antenna should be avoided for transmissions. The trailing antenna introduces a noticeable error, once again due to excessive horizontal polarization, that does not seem to appear on a fixed antenna. This error is maximum when the plane is abeam of the station.

Conclusion

It has not been the objective of this article to cover every phase of radio navigation for aircraft, but rather to introduce a science generally unfamiliar

[Continued on page 55]

MEISSNER Signal Shifter



**Permits instant
Frequency change
in any given band
... right from the
operating position!**

The newly developed general coverage plug-in coils have extended the range of the Signal Shifter to cover frequencies from 1,000 kc. to 16,500 kc.

Install the Meissner Signal Shifter and your crystal procurement problems are solved! The Signal Shifter provides continuous coverage of a frequency range from 1000 kc. to 16,500 kc. without any sacrifice in stability ... **NO CRYSTALS REQUIRED!**

The Meissner Signal Shifter is a variable frequency exciter of exceptional stability ... may be used alone as an auxiliary or "Short-Haul" C-W transmitter. All tuned circuits are gang-controlled by a high quality precision vernier dial.

For further details see your Meissner distributor or write

Meissner
MT. CARMEL, ILLINOIS

"PRECISION BUILT PRODUCTS"

TO EXECUTIVES:

NOW YOU CAN HELP

Even More...

New Treasury Ruling Permits Purchases
UP TO \$100,000, in any Calendar Year, of
Series F and G WAR BONDS!



The Treasury's decision to increase the limitations on the F and G Bonds resulted from numerous requests by purchasers who asked the opportunity to put more money into the war program.

This is not a new Bond issue and not a new series of War Bonds. Thousands of individuals, corporations, labor unions, and other organizations have this year already purchased \$50,000 of Series F and G Bonds, the old limit. Under the new regulations, however, these Bond holders will be permitted to make additional purchases of \$50,000 in the remaining months of the year. The new limitation on holdings of \$100,000 in any one calendar year in either Series F or G, or in both series combined, is on the cost price, not on the maturity value.

Series F and G Bonds are intended primarily for larger investors and may be registered in the names of fiduciaries, corporations, labor unions and other groups, as well as in the names of individuals.

The Series F Bond is a 12-year appreciation Bond, issued on a discount basis at 74 percent of maturity value. If held to maturity, 12 years from the date of issue, the Bond draws interest equivalent to 2.53 percent a year; computed on the purchase price, compounded semiannually.

The Series G Bond is a 12-year current income Bond issued at par, and draws interest of 2.5 percent a year, paid semiannually by Treasury check.

Don't delay—your "fighting dollars" are needed *now*. Your bank or post office has full details.

Save With . . .



War Savings Bonds

This space is a contribution to America's All-Out War Program by

RADIO

RADIO

* JANUARY, 1943



RADIO is for radiomen!

The editorial contents are devoted strictly to radio design, engineering, production and operation. The "Bibliographies", "Design Worksheets", and data on the theory and application of radio devices **published exclusively in RADIO**, are helpful to every engineer and technician engaged in civilian and military radio work.

=====Subscribe today! This special offer expires February 15th.=====

15 Big Issues-\$3.00

instead of the regular price of
\$3.00 for 12 issues

*Special: Subscription price to men
in the armed service \$1.50 per year*

27 Big Issues-\$5.00

instead of the regular price of
\$5.00 for 24 issues

TEAR OUT AND MAIL-----Use the Coupon Below-----TEAR OUT AND MAIL
It must be filled-in completely.

"RADIO"

Radio Magazines, Inc.
132 W. 43rd St., New York City

SPECIAL MONEY-SAVING OFFER

Valid until Feb. 15, 1943
15 issues \$3.00—27 issues \$5.00

SIRS: Please send me the next . . . issues of RADIO. Here is my ☐ check (or ☐ money order) for \$. . . .
(Remit by Check or Money Order. We cannot assume responsibility for cash sent thru mails)

Name (print carefully)

Address City State

Name of Firm You Work For

Title or Position You Hold (please be explicit)

iar to many radiomen. DF equipment has been so tremendously expanded and developed in the past several years that volumes would scarcely cover the subject.

Today, international carriers and aircraft ferries combine radio and celestial navigation to a degree of perfection that makes scheduled long-distance flights commonplace.

With the commercial future of international airplane flying assured as a major industry, the place radio navigation will hold in its future development and operations bears close watching by all technical men.

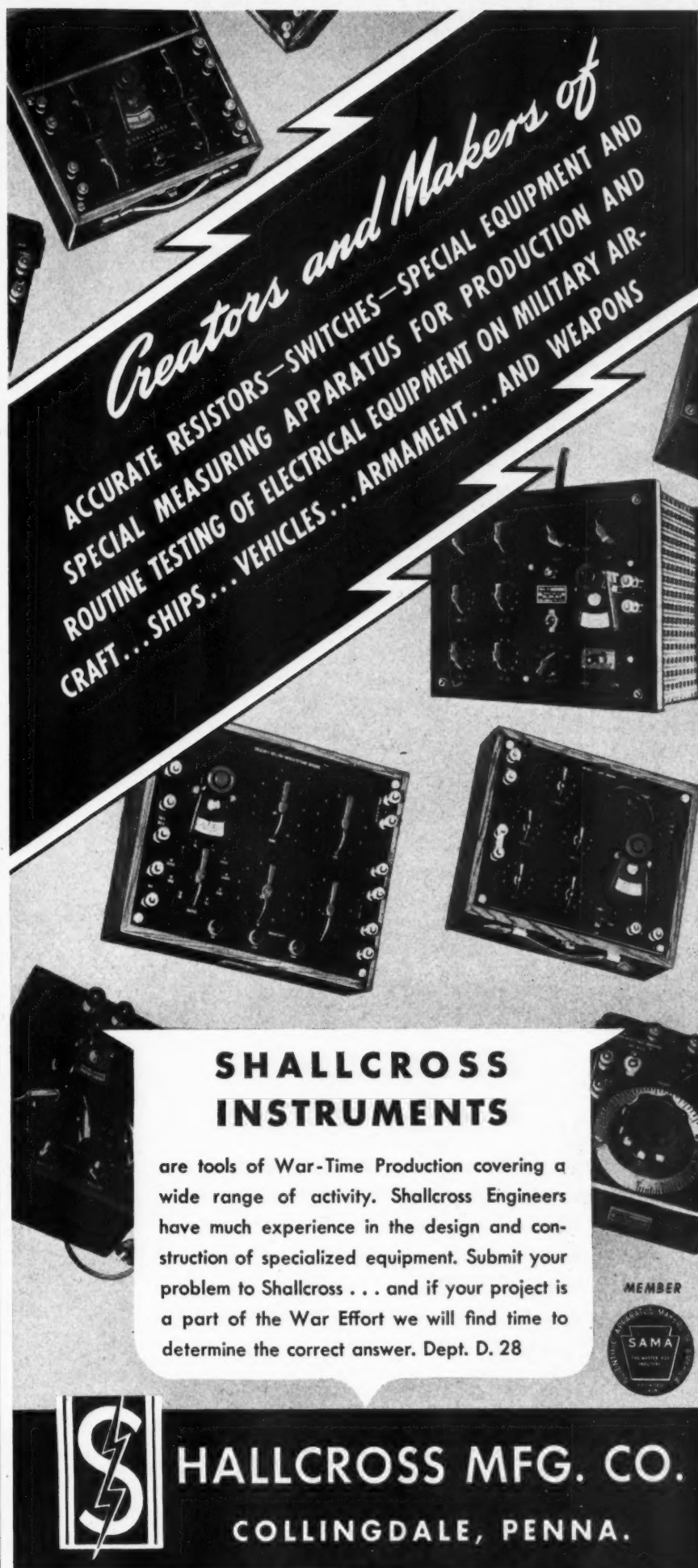
FM EMERGENCY EQUIPMENT

[Continued from page 19]

securely in place beneath the chassis by a strong and neatly formed coil support.

Each transmitter and receiver is designed basically to operate successfully over the entire 30- to 42-mc band, and the "air-trimmer condensers" and "iron core tuning units" must obviously have sufficient range to accomplish the necessary changes to cover the whole band. It is evident that an air-trimmer condenser is either "all in" or "all out" with one-half turn of the adjusting screw driver. We have selected, however, a combination of iron-core tuning elements in the new design that provides for approximately thirty whole revolutions to cover the entire band. The comparative effect is as shown in Fig. 9. Curve A illustrates the variation in response of a particular circuit with the earlier design of equipment. The optimum performance point corresponds with the peak of the curve, and it is obvious that the initial setting must be extremely accurate, and that, similarly, any shifting of these tuning elements due to car vibration would be very critical. Now compare Curve B, which shows the variation in response with adjustments of the iron core tuning units near their proper setting. Since the optimum performance point is still at the peak, it is perfectly evident that the initial setting is far less critical, and, similarly, that changes due to vibration have less effect on ultimate performance.

A typical improvement of the modern unit, from the serviceman's standpoint is shown in Fig. 10. A shows the earlier unit lying on its side for servicing or inspection, whereas, B illustrates a substantial and rigid work bench support for the new unit. It will be noted that, as shown in C, the work-



Creators and Makers of

ACCURATE RESISTORS—SWITCHES—SPECIAL EQUIPMENT AND
SPECIAL MEASURING APPARATUS FOR PRODUCTION AND
ROUTINE TESTING OF ELECTRICAL EQUIPMENT ON MILITARY AIR-
CRAFT... SHIPS... VEHICLES... ARMAMENT... AND WEAPONS

**SHALLCROSS
INSTRUMENTS**

are tools of War-Time Production covering a wide range of activity. Shallcross Engineers have much experience in the design and construction of specialized equipment. Submit your problem to Shallcross . . . and if your project is a part of the War Effort we will find time to determine the correct answer. Dept. D. 28

HALLCROSS MFG. CO.
COLLINGDALE, PENNA.

MEMBER
SAMA
THE NATIONAL ASSOCIATION OF MANUFACTURERS

bench support serves as the cover latch mechanism, the cover being removed by a quarter turn of a single handle; and from *D*, that the work-bench support is easily removed to facilitate servicing the top of the chassis.

Two other important factors should be mentioned: First, that this modern equipment which we refer to as the "All American" design, embodies many features suggested by hundreds of actual users who were contacted by means of a design questionnaire distributed by the General Electric Market Research Bureau. We hasten to pay trib-

ute to the practical knowledge, the technical skill, and the thoroughly co-operative attitude of these hundreds of operators. Second, that this design is "keyed" to the war emergency period by having given special attention to the reduction in critical materials used. We mention three specific items.

1—While this is a double-conversion superheterodyne receiver, we use a single crystal to control both heterodyning functions by making use of both the fundamental and the sixth harmonic of the crystal.

2—Air-trimmer condensers have

been a serious limiting item for military equipment, and whereas our earlier unit used 22 of these per two-way equipment, we now use only five.

3—More than 50% reduction has been made in the amount of aluminum used.

Conclusion

By no means do we write "finis" to development work in this important communication field. Progress will be made in the future just as it has always been made in the past. We believe that it will be evident, however, that with "time" as the base of our curve, accomplished development put into action during these two and one-half years would now appear as a rapidly rising curve which has very materially levelled off into a period of refinement in circuit and component detail. We hasten to add that this last statement relates only to frequency modulation as now used in the 30- to 42-mc band for the emergency communication services. Much still remains to be done in the field of relaying equipment in the higher frequency bands and in antenna development. And furthermore, it is definitely not a function of this article to discuss developments in other parts of the spectrum, which work will, without question, receive tremendous acceleration due to the total war effort. Frequency modulation in the present 30- to 42-mc band has proven to be so valuable a communication tool, however, that whatever the developments which will surely expand the horizon of the emergency communication services, the present service will still be widely used.

AIRCRAFT RADIO MAINTENANCE

[Continued from page 32]

Volume controls, fuses and switches are replaced. Jack boxes, control panels and rotatable loop gear boxes are removed from the ship for a complete bench overhaul. All connecting cables are given voltage breakdown and leakage tests. Radio racks and hold-down clamps are tightened and put into first class condition. At this time, in short, all radio and related equipment receives a complete overhaul.

Major Check

The 5000-hour major check takes place during the complete aircraft overhaul period. At this time connecting cables otherwise inaccessible can be reached and replaced. Also replaced are antennae, insulators and fuse clips. When an aircraft leaves the hangar



LET'S ALL PITCH IN!

WE CAN all help win this war by selling our government the communication receivers and transmitters they need quickly and in sufficient quantities.

That is the reason I am paying *highest cash prices* for used communications equipment.

When this war for the "four freedoms" is over you will undoubtedly be in the market for new equipment and by taking advantage of my offer to purchase your present equipment at highest cash prices you will be in a position to buy a new and better receiver than you now own.

Write, telephone or telegraph me description of your used communications receivers and transmitters of standard make; you will be paid cash immediately without bother or red tape.

I also have a store at 2335 Westwood Blvd., West Los Angeles, Calif.



"WORLD'S LARGEST DISTRIBUTOR OF COMMUNICATIONS RECEIVERS"



after a major overhaul it is as air-worthy as the day it left the production line.

Pre-failure radio maintenance keeps the airlines' 170 transports flying an average of ten hours out of each twenty-four. In addition, radio equipment is constantly being modernized. As many as fifteen radio "projects" may be made during a one-year period as new ways are found to improve the operating efficiency of equipment. Records of service failures are carefully compiled and studied. Maintenance routine is altered accordingly. Radio maintenance is a big part of a big industry, and radio maintenance personnel can be proud of their contributions to the aviation art.

THERMAL RADIO

[Continued from page 25]

able that a higher range of frequencies will come into use.

Calculation of Power Required

The amount of heat (in gram calories) required to raise the temperature of a certain quantity of wood—or any material—a certain number of degrees can be calculated from the relation:

$$H = pc\Delta t \cdot \text{volume}$$

where: p = specific heat (cal. per gram per deg. C.)

c = density (gram per cc.)

Δt = change in temperature (deg. C.)

v = volume (cc.)

The power required to produce this amount of heat in a given time is:

$$P(\text{watts}) = \frac{4.187 \times H}{\text{time (sec.)}} = \frac{4.18 \cdot pc \cdot \Delta t \cdot \text{volume}}{\text{time (sec.)}}$$

If we substitute cu. in. for cc., and deg. F for deg. C, and time in minutes:

$$P(\text{watts}) = \frac{.637 \cdot pc \cdot \Delta T \cdot \text{volume (cu. in.)}}{\text{time (min.)}}$$

where: ΔT = degrees F.

In some cases it is more convenient to express this in terms of required power concentration, viz:

$$\text{power concentration} = \frac{.637 pc \Delta T}{\text{time (min.)}} \quad (\text{watts/cu. in.})$$

In other cases where a limited amount of power is available it may be desired to know the time required to raise the material so many degrees. This is simply:

$$\text{time (min.)} = \frac{.637 pc \Delta T}{\text{watts/cu. in.}}$$

Advantages of the RF Method

The more obvious advantages of the

DIE-LESS DUPLICATING



An almost unlimited variety of work can be rapidly done by the combined use of these 3 Di-Acro units. High hourly production rates can be easily maintained. Multiple units provide large output if desired. All duplicated work is accurate to .001".

Are you in a rush for some duplicated metal parts? Do you have experimental work? In many cases you can make the parts faster with the "Di-Acro" system, and avoid entirely the expense and delay of making dies. You can save valuable Man Hours and needed Critical Materials.

In illustration above from left to right: 1st—Di-Acro Shear squares and sizes material, cuts strips, makes slits or notches. 2nd—Di-Acro Brake forms angles, channels or "Vees". 3rd—Di-Acro Bender bends angle, channel, rod, tubing, wire, moulding, strip stock, etc. Send for catalog, "Metal Duplicating Without Dies."

Write
for
Catalog



O'NEIL-IRWIN MFG. CO.

346 8th Ave. S.,
MINNEAPOLIS, MINN.

Under the Sea Pincor Products

Keep 'Em Winning!

DYNAMOTORS * CONVERTERS * GENERATORS
D.C. MOTORS * POWER PLANTS * GEN-E-MOTORS

PIONEER GEN-E-MOTOR

CHICAGO, ILLINOIS
EXPORT ADDRESS: 25 WARREN STREET, N. Y., N. Y.
CABLE: SIMONTRICE, NEW YORK

RADIO AND ELECTRONIC PARTS DELIVERED

.... Now!

FOR ALMOST a quarter of a century Lafayette has maintained quick, accurate delivery service from complete stocks—one or a thousand units, there is no order too small or too large.

ENGINEERS: Get acquainted with Lafayette's immediate delivery service—send in your order now to this ONE CENTRAL SUPPLY DEPOT for those hard to find parts—radio, electronic, or sound. Draw on the thousands of varied items now in Lafayette's stockrooms. You can depend on Lafayette quality.

FREE! 130 page illustrated CATALOG containing thousands of items indexed for quick reference—order your copy now! Address 901 W. Jackson Blvd., Chicago—Dept. 1F3.

Camera Fans: Photographic Equipment at lowest prices. Write for FREE PHOTOGRAPHIC CATALOG.

LAFAYETTE RADIO CORP.

901 W. JACKSON BLVD., CHICAGO, ILL. 265 PEACHTREE STREET, ATLANTA, GA.

NATIONAL UNION IS READY TO GREET ELECTRONIC SERVICE MEN

FROM THE SMOKE AND MIRAGE OF BATTLE SHALL ARISE
A GREATER, STRONGER SERVICE INDUSTRY

Every ounce of National Union energy is thrown into the battle for victory. Our engineering, our production, our manpower and machinery are in the fight. As we battle on the research and production front we see the dawn of great new horizons as new products, new and better methods develop, we see the Radio Service man to whom we have devoted ourselves through the years standing on the threshold of a greater opportunity than he has ever known. National Union is deeply grateful for the loyalty of the service profession to National Union products. National Union is learning, watching every advancement in the electronic art, so when the day of Victory comes, the many thousands of service men who have grown with us in the past shall benefit in the future.

NATIONAL UNION RADIO Corp. 57 STATE STREET, NEWARK, NEW JERSEY

radio-frequency method follow from the fact that in this method heat is caused to be generated simultaneously and uniformly throughout the whole body of the wood. This means that (neglecting losses) the whole block of wood comes up to temperature evenly. It also means that the time required for a given increase in temperature is independent of the thickness of the wood. These effects are in marked contrast to those which occur with other methods of heating. In all other methods heat which originates outside the wood (as, for instance, in steam platens) must travel into the wood by conduction. As a result, the outer layers of the wood come up to temperature much more quickly than the interior. Moreover, the time required to heat a section of wood depends entirely on the thickness. In the case of thick sections this becomes very long.

An important advantage where new press installations are considered is the fact that the presses themselves can be of much cheaper design, since the massiveness associated with steam plates and multiple openings is done away with. Moreover, the use of radio frequency makes it much easier to use "hot" gluing in conjunction with very large presses and presses of unwieldy dimensions. Presses designed originally for cold gluing are readily adapted for hot gluing.

There are also a number of minor advantages which vary in accordance with the job to be done. These include the convenience of not having to work in close proximity to hot plates; the fact that the heat can be closely controlled and can be turned off instantly; the possibility of making hot-glued joints on jigs designed for cold gluing; and others of a similar nature. The importance of these will become more evident as this process comes into more widespread use.

When making compregwood parts radio frequency has another very important advantage. This is the fact that since the whole mass of wood is heated uniformly the compression takes place uniformly. The contrast with what takes place when using a steam die only is very marked. In the latter instance the outer plies, of course, heat up very quickly and the resin in them begins to set up. Compression must, therefore, be started immediately. However, at this point the interior of the wood has not even started to heat. As a result the compression is very non-uniform and terrific internal stresses result. Such stresses can be partially relieved by very long cooking periods, but even then results are often unsatisfactory. Direct comparisons made between similar sections done with and without radio frequency show

that in the latter these stresses have been 90% or more eliminated.

All of the above advantages are cited on the basis of work which has actually been done. In considering the use of radio frequency for making curved surfaces such as fully-stressed wing or fuselage elements, it should be noted that this is something which apparently has not yet been done in production. Should the radio-frequency process be found feasible, there would, of course, be marked advantages. While the autoclave method appears to be the most satisfactory found to date, it is unquestionably cumbersome, time-consuming and expensive. Use of r.f. might conceivably eliminate the cost of the autoclave, greatly reduce the time cycle, the quantity of jigs required, the number of operations and the inconveniences attendant on the present process. There are a number of problems to be worked out before this will be possible, but already the answers to some of these have been indicated.

Limiting Factors

With all the advantages of radio frequency one wonders why it has not been more widely adopted. The answer seems to lie in the fact that there are definite problems in applying it to other than simple jobs. These problems have been too much for wood engineers to solve by themselves and—at least until very recently—radio engineers have not been interested. The present plywood plane and glider program has changed this situation overnight. The importance of this work, plus the necessity for quantity production, plus the desirability of using phenol glues have caused a sudden demand for radio-frequency equipment. This has revived the interest of radio engineers and they are now tackling these application problems on a wide front.

★

THIS MONTH

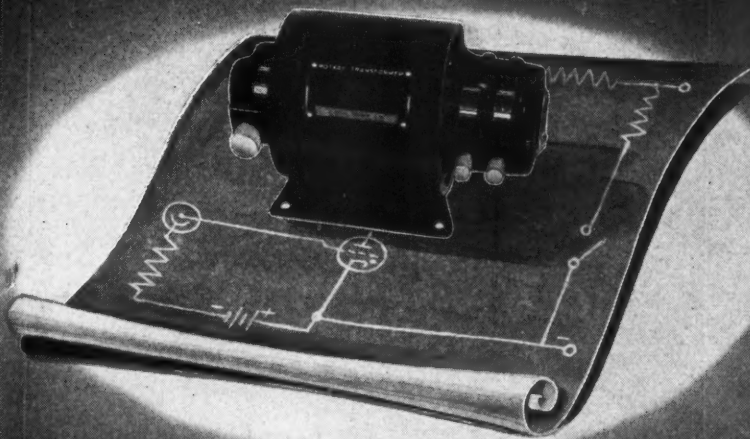
[Continued from page 26]

(d) Section 10.123 Coordinated service — The amendment does not change the present licensing procedure but clarifies the agreements that must be submitted with the application for an instrument of authorization in those cases where it is proposed to render a coordinated communication service.

International Broadcasting

At the request of the Board of War Communications, the Federal Communications Commission allocated two additional frequencies to the international broadcast service for the duration of

CARTER SOLVES YOUR *Dynamotor* PROBLEMS



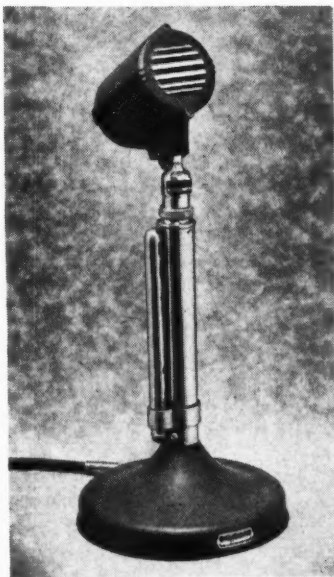
For many years, Carter Dynamotors have been a familiar part of the specifications of leading Communication Equipment Manufacturers, Police Departments, Government Agencies, etc. May we suggest you submit your Dynamotor requirements too, and see for yourself the reason for this recognized preference.

The latest catalog of Carter Dynamotors, Converters, Permanent Magnet Generators and Dynamotors, and special rotary equipment will be sent upon request.

Carter Motor Co.
Chicago, Illinois

1605 Milwaukee Ave. Carter, a well known name in radio for over twenty years. Cable: Genemotor

GDN SERIES MICROPHONES



Designed especially for important communication applications at air base and marine ground stations, on ships, and for similar uses, Astatic GDN Series, Dynamic Microphones combine highest operating efficiency with greater practicability of handling. This microphone, available in high and low impedance models, of 50 to 50,000 ohms, is shown, in the accompanying illustration, in combination with Astatic's Grip-to-Talk Desk Stand embodying a relay operating OFF-ON switch for remote control of transmitters and amplifiers. GDN Series Microphones are procurable from your Radio Parts Jobber upon presentation of necessary priority ratings.

ASTATIC

THE ASTATIC CORPORATION

YOUNGSTOWN, OHIO

Licensed Under Bush Development Co. Patents

In Canada Canadian Astatic Ltd. Toronto, Ontario

DYNAMOTORS

...and Dog-fights!



The men in the planes can tell you that it takes perfect coordination of every factor—of manpower, plane and instruments—to come out on top in a dog-fight. Dynamotors don't do the shooting—but they furnish the necessary power for radio communications, direction-finding, radio compass and other instrument controls which enable our men to find the enemy, attack and come back safely. Eicor Engineers are proud of the job Eicor Dynamotors are doing today in fighters, bombers, trainers and transports.

EICOR INC. 1501 W. Congress St., Chicago, U. S. A.
DYNAMOTORS • D. C. MOTORS • POWER PLANTS • CONVERTERS
Export: Ad Auriema, 89 Broad St., New York, U. S. A. Cable: Auriema, New York

WANTED:

Ideas for Post-War Products

● When the war is over, America and the world will have many new products. These new items have not yet been made—except in an experimental way. For the most part they exist only in the minds of creative men in the fields of radio and electronics.

If you have ideas for post-war products, we would like to hear from you. Our engineering staff and well-equipped factory are capable of developing and producing your ideas.

We will pay you for them, of course. As a first step we suggest that you send us a letter telling what you have in mind. Address it to Max L. Haas, President, Bud Radio, Inc., 2118 East 55th St., Cleveland, Ohio.



BUD RADIO, INC.

CLEVELAND, OHIO

the war. These two frequencies, 7805 and 7935 kilocycles, are available for assignment to zone and inter-zone police stations under the provisions of Section 10.44 of the Commission's Rules and Regulations. On the basis that the broadcast transmissions will be intended for reception outside the continental United States and that most of the zone and inter-zone police communication on these frequencies occurs during daylight hours, it is not expected that the police service will cause any interference to the international broadcast service. Zone and inter-zone police stations now licensed to operate on 7805 and 7935 kilocycles will be permitted to continue the use of these frequencies, upon the express condition that these stations do not interfere with the international broadcast service, and subject to such pertinent orders, rules, and regulations as the Commission hereafter may deem necessary to prevent such interference.

★

HE KEEPS 'EM ROLLING

Walter Schiller, coxswain on a U. S. battlewagon at Pearl Harbor, used to use Universal microphones in boat drills and other maneuvers. Now he is having a part in making the tiny precision instruments at the Inglewood, Cal., plant of the Universal Microphone Co. With more than two dozen bullet wounds, shrapnel cuts and scars, Coxswain Schiller has returned to civilian life.

Universal plans to extend its use of returned service men and rehabilitates for working on defense orders for all arms of the service.

★

NEW NATIONAL UNION PLANT

With construction completed well ahead of schedule, the new plant of the National Union Radio Corporation at Lansdale, Pa., was formally opened with impressive ceremonies in which Army and Navy officers participated.

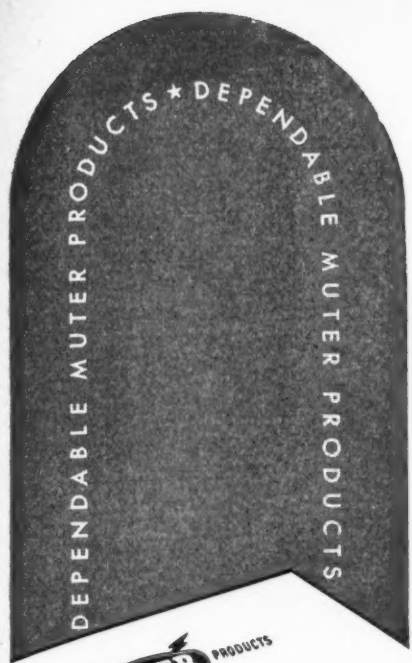
The new plant, representing the most advanced design and construction, is 40,000 square feet in area. Included in it are offices, laboratories, and complete manufacturing facilities. All activities are carried out on a single level.

★

NEW SOLAR SUBSIDIARY

To assist their jobbers, the Solar Manufacturing Corporation, Bayonne, New Jersey, has transferred all jobber sales activities to a new subsidiary organization, which will be known as the Solar Capacitor Sales Corporation.

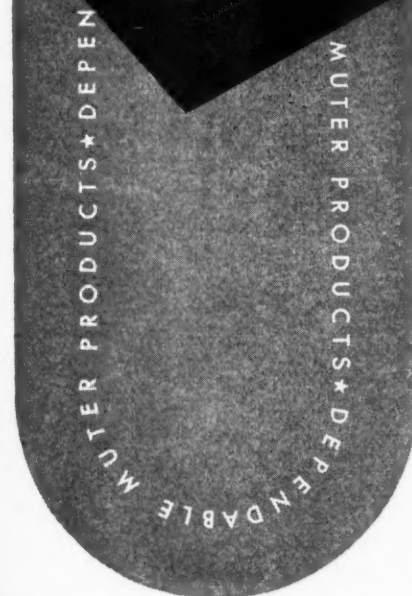
Solar Capacitor Sales Corporation, like its parent company, will be located at Bayonne, New Jersey, and will operate under the guidance of the same



DEPENDABLE **MUTER** PRODUCTS

**Manufacturers
of Component parts for
the Radio, Electronic
and Communications**

THE MUTER CO.
1255 South Michigan Avenue
Chicago, U. S. A.



management, including W. C. Harter as general sales manager, Sy Wolin as sales manager, and A. Prosdocimi as manager of the Export Division.

★

DR. POWER HONORED

Dr. Ralph L. Power, Los Angeles radio counsellor, on the eve of celebrating the end of 20 years in radio, has received notice that the Council of the Australian Institute of Radio Engineers has elected him to Companion grade. In recent years he has been engaged in radio exporting, but has continued to supervise advertising accounts for clients. His oldest client is the Universal Microphone Co.

★

NEW LANGEVIN PLANT COMPLETED

The Langevin Company has just completed their new transformer plant at 37 West 65th Street, New York City. This plant will specialize in the manufacture of electrical transformers of all types for use in radio and Radar communication work. Area occupied totals approximately 16,000 sq. ft. Complete tool room facilities are incorporated in order to expedite fabrication of parts normally procured through outside sources.

★

ARMY-NAVY "E" TO RADIOMARINE

The Army-Navy Production Award for achievement in manufacturing radio equipment for war was presented to Radiomarine Corporation of America by Rear Admiral William C. Watts, U. S. Navy (Ret.), and Brig. General Ralph K. Robertson, Commanding General, Metropolitan Military District, in a ceremony on December 19th at the company's plant, 75 Varick Street. Lieut. John D. Lodge, U. S. Navy Reserve, acted as chairman of the program.

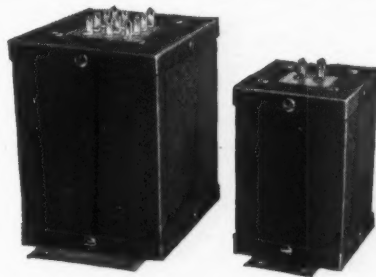
★

RMA-BEW EXPORT COMMITTEE

A special RMA-BEW Export Committee, for cooperation with officials of the Board of Economic Warfare on radio export problems, has been appointed by Paul V. Galvin, President of RMA. The special RMA committee was suggested recently by Assistant Director Hector Lazo of BEW in general charge of export procedure, and is headed by W. A. Coogan of New York, chairman of the RMA general committee on foreign trade matters. Other members appointed to the special RMA-BEW Committee are: Ad. Auriema of New York, Jay Cooke of Camden, New Jersey, D. McIntosh of New York and Arthur Rocke of New York. All members of the special RMA-BEW committee have traveled

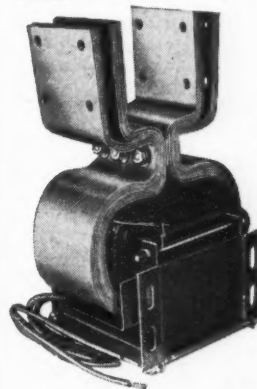
WAR PRODUCTION TRANSFORMERS

★ You name the specifications and we'll design the transformers to meet the most exacting performance limitations of your application. Whether it be standard or special characteristics, Acme's trained production organization and specialized transformer manufacturing facilities can serve you better.

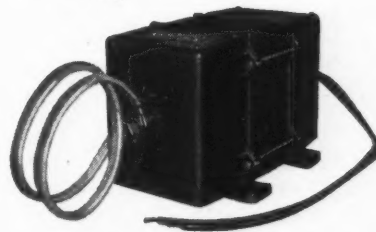


For Example

Acme compound-filled communication transformers, for mobile and air-borne war equipment are tested to successfully withstand all temperature and climatic conditions.



This Welding Transformer is another special design application. For operation on 115 volt, single phase, 60 cycle primary circuit with secondary characteristics of 0.75 volt, 1600 amperes.



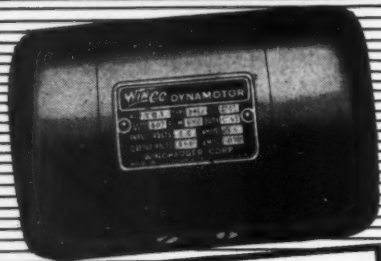
Isolating Transformer

To eliminate extraneous interference caused by power lines entering shielded test rooms, this Acme Isolating Transformer has a completely shielded secondary winding and shielded secondary terminal leads. Secondary provides a relatively constant voltage for testing purposes, unaffected by the use of instruments, soldering irons, lighting or on-and-off switching. Rated at 2 KVA with 50% overload capacity and 1% regulation at 1 KVA.

THE ACME ELECTRIC & MFG. CO.
55 Water St. Cuba, New York

Acme Electric
TRANSFORMERS

ONLY WINCO GIVES YOU ALTI-TEMP DYNAMOTORS



Where complete dependability is essential . . . where efficient electric power is important . . . specify WINCO DYNAMOTORS! WINCO DYNAMOTORS are built for all types of service . . . for operating temperatures ranging from -40° to $+65^{\circ}$ Centigrade.

**COMPACT
LIGHT WEIGHT
MINIMUM A.C. RIPPLE
LOW VOLTAGE REGULATION**

These are only a few of the quality features in WINCO DYNAMOTORS.

WINCO DYNAMOTORS are regularly available in standard outputs and sizes . . . special WINCO DYNAMOTORS can be designed to meet your exact need. Our complete free Advisory Engineering Service is yours without obligation —why not consult us?

The Dynamotor designed to insure maximum efficiency at all operating altitudes and temperatures.

WINCO DYNAMOTORS
WINCHARGER CORPORATION
SIOUX CITY IOWA

extensively in foreign countries and represent many RMA companies and interests in foreign sales of all radio products.

Many radio export problems, including the use of PD-1A application forms for export business, were discussed at an RMA-BEW-WPB conference December 15. Instead of using PD-1X forms, which have been found not adaptable for radio exports, the present procedure arranged is for filing of the PD-1A application covering each export shipment proposed. Other industry recommendations for further help to radio export departments were submitted and are under consideration.

RMA was represented at the radio export conference by the new Special Committee for Cooperation with BEW. Several BEW officials included Kenneth Campbell, George Donnelly and Albert Waterston. The WPB Radio and Radar Division was represented by Chief Frank H. McIntosh, Glen C. Henry and Ralph D. Camp of the Domestic and Foreign Radio Section. Another conference with the RMA committee will be held next month.

The shipping situation, according to information developed at the December 15 meeting, is not improving for several markets, and export licenses promise to be curtailed during early 1943.

Limited future assembly of sets and also kits, to be earmarked for export, was discussed tentatively at the December 15 meeting, but no definite conclusions were reached, partly because of uniformly unbalanced supplies of components in manufacturers' inventories. Several other plans on export matters

included the possibility of tube shipments on a two-month quota basis, based on previous export shipments of manufacturers, and also adoption of PD-1A applications for domestic jobber exports. Lend-lease shipments also were discussed and will be a special subject for the January meeting.

★

REPROOF

Editor, RADIO:

I note a serious technical error in your scientific article on the Gremlins in the November issue of RADIO. You refer to the reverse locomotion of the dodo bird. It is my understanding that the dodo bird is extinct and that it is the fillilu bird which flies backwards, due, of course, to a complete lack of interest in destination coupled with considerable concern as to his point of departure.

C. W. Metcalf

TOBE DEUTSCHMANN CORP.

We stand corrected. But there are Gremlins.—Ed.

ALLIED'S FORMULA AND DATA BOOK

Allied Radio Corporation, Chicago, announces the publication of a new handy, pocket-sized handbook of most frequently used mathematical formulas, tables, data and standards in the field of radio and electronics. This booklet, edited by Nelson M. Cooke, Chief Radio Electrician, U. S. Navy, eliminates time-consuming search through numerous books for informa-



The bomber must be built and the crew must be trained.

In war plants and in training stations throughout America, BOGEN CENTRALIZED SOUND SYSTEMS are helping to build the ships and train the men — expediting production, locating vital men instantly, issuing orders and automatic signals and alarms.

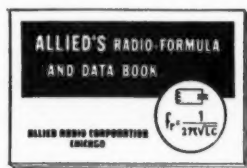
May we tell you how?

DAVID BOGEN CO., INC.
663 BROADWAY,
NEW YORK CITY



tion constantly used by radio and electronic engineers and maintenance men.

Available for instant reference are formulas, tables and data covering such subjects as Ohms Law; inductance; reactance; impedance; resonance; the use



of exponents, trigonometric relationships, logarithms, radio color codes, abbreviations, mathematical symbols, wire tables, etc. Included also is a condensed selection of formulas pertaining to meters and vacuum tubes.

This new Allied publication is priced at 10c. It may be obtained from Allied Radio Corporation, 833 West Jackson Boulevard, Chicago, Illinois.

★

TRANSMISSION-LINE IMPEDANCE PROBLEMS

Harold A. Wheeler, engineer, Hazeltine Service Corporation, presented a paper on "The Hemisphere Chart for Transmission-Line Impedance Problems" at the meeting of the Radio Club of America, Thursday, January 14th, at Columbia University.

The chart discussed by Mr. Wheeler was proposed by P. S. Carter, and is useful in connection with transmission lines and impedance matching. The paper included the solution of a number of problems, such as the matching of antenna impedance to a transmission line. The speaker illustrated how

this chart in itself gives the impedance of a transmission line when terminated by any impedance.

★

G. E. BOOKLET ON ELECTRONICS

"Electronics—A New Science for a New World" is the name of a colorful, pictorial booklet issued by General Electric presenting the general story of electronics—its past, its present, and its great possibilities for the future.

Colorful accounts by word and illustration are told of how the electron is working today in war combat to perform many marvelous functions; in research to reveal more of nature's mysteries; in industry to step up production, increase human efficiency, and reduce material waste; in radio and television to extend the range and quality of sound and sight over the air waves; in agriculture to improve quantity and quality; and in medicine to reveal more and more of the structure and behavior of the human body.

A copy of the new booklet may be obtained by writing the General Electric Company, Schenectady, N. Y., and asking for booklet GED-1024.

★

MEISSNER GETS ARMY-NAVY "E"

Meissner Manufacturing Company, Mt. Carmel, Illinois has been awarded the Army and Navy "E" for excellence in production. The award was presented to The Meissner Company at their plant on December fourth.

Among those who participated in the award were Major W. G. Mee and Major Robert Orr representing the United States Army, and Captain Robert Henderson and Lieut. Crabtree representing the United States Navy.

ALL OUT FOR VICTORY

AND WISHFUL THINKING WON'T DO.

There is no place in today's picture for wishing, watching and wondering.

Sacrifice, hard work, faith and enthusiasm represent only a small part of what is necessary to win this fight—and it is a fight.

GIVE IT EVERYTHING YOU'VE GOT — AND MORE.

Erwood Sound Equipment Co.

223 WEST ERIE STREET

CHICAGO, ILL.

We are

Pitching

for

Uncle Sam

for the

Duration!

!

Our Army
of workers
and engineers
will be intact
—to serve our
many good
customers—

when it's over
over there!

!

HENRY FORSTER

President

RADIO SPEAKERS

INCORPORATED

221 East Cullerton St.
Chicago, Illinois

A LOT in a small PACKAGE



• Yes, that's the story of Aerovox PBS cardboard-case dry electrolytics. Like-wise adjustable metal mounting flanges; polarity-indicating colored leads; generous voltage ratings; full capacity—these and other features brand them as ideal electrolytics when pennies count — and when radio-service reputation is at stake.

Type PBS600—600 v. D.C.W.
Single Section: 4 and 8 mfd.
Type PBS450—450 v. D.C.W.
Single Section: 2 to 16 mfd.
Double Section: 4-4 to 8-16 mfd.
Triple Section: 8-8-8 mfd.
Type PBS250—250 v. D.C.W.
Single Section: 2 to 30 mfd.
Double Section: 4-4 to 16-16 mfd.
Triple Section: 8-8-8 to 8-8-16 mfd.
Type PBS100—100 v. D.C.W.
Single Section: 5 and 10 mfd.
Type PBS50—50 v. D.C.W.
Single Section: 5, 10 and 25 mfd.
Type PBS25—25 v. D.C.W.
Single Section: 5, 10 and 25 mfd.

• Ask Our Jobber . . .

He'll gladly supply you with these Aerovox money-saving PBS electrolytics he stocks for your constant convenience. Ask for latest Aerovox catalog — or write us direct.



KNOWLSON RESIGNS FROM WPB

Resignation of James S. Knowlson as Vice Chairman of the War Production Board was announced January 4th by Chairman Donald M. Nelson. In making the announcement Mr. Nelson said that he was retaining Mr. Knowlson within the WPB organization on a "when actually employed" basis, so that he could be called on as a consultant or special assistant from time to time.

Mr. Knowlson resigned in order to return to his duties as President and Chairman of the Board of the Stewart-Warner Corporation in Chicago. This firm has a large volume of war orders, and Mr. Knowlson — who came to Washington 15 months ago expecting to stay three months—felt that he could no longer remain away from its helm.

NEW PRODUCTS

[Continued from page 48]

SHALLCROSS WHEATSTONE BRIDGE

The new Shallcross No. 630 Wheatstone Bridge provides accurate, convenient, and direct electrical resistance measurement from 0.1 to 11,100,000 ohms. Its accuracy is 1% between 10 and 1,000,000 ohms. The galvanometer has a sensitivity of 1 microampere per millimeter division.



The three decades of the rheostat arm are connected to external binding posts, thus enabling the Bridge to be used as a resistance box from 10 ohms to 11,000 ohms in an external circuit. Each decade consists of 10 wire-wound resistors. These resistance units are wound with Manganin wire on a non-hygroscopic form. The switches are Shallcross standard high quality, having ceramic switch plates, brass contacts and multi-leaf phosphor bronze arms.



AVIATION RADIO RANGE FILTERS - TRANSMITTERS

RELAY COILS TRANSFORMERS -

ELECTRONIC EQUIPMENTS AND TEST UNITS

**OXFORD-TARTAK
RADIO CORPORATION**

3911 S. Michigan Ave., Chicago, Ill.

Covington LAPIDARY EQUIPMENT

FOR QUARTZ CRYSTAL PRODUCTION
Used by the U. S. Government

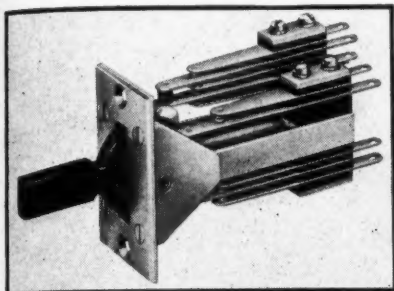


For detailed information, write the Shallcross Mfg. Co., Dept. 28, Collingdale, Penna.

★

MOSSMAN LEVER SWITCH

Donald P. Mossman, Inc., 6133 N. Northwest Highway, Chicago, has published a General Data Bulletin No. 82 on their new O-42 Lever Switch.



The Mossman O-42 Lever Switch is primarily designed for use in Aircraft, Radio, Communication, Annunciator and Fire Alarm Systems, Testing Apparatus and a wide range of Industrial applications. It is available in an almost unlimited series of combinations of contact assemblies. Contacts, pile-ups and lever action is assembled to meet the specific requirement.

VOKAR

CURRENTLY PRODUCING

JK26 JK48 JACKS
FT243 CRYSTAL HOLDERS

★ ★

Radio and Electrical
Assemblies

★ ★

WRITE FOR
INFORMATION

★ ★

ELECTRONIC PRODUCTS
MFG. CORP.

7300 Huron River Drive
DEXTER, MICHIGAN

This switch has positive action—locking, non-locking (spring return to neutral position) and no throw stops. A large, well formed handle permits a firm grip by a gloved hand. Rating—maximum recommended — 5 amperes, 110 volt, a.c., (non-inductive).

Diagram and complete information is given in the General Data Bulletin No. 82, which will be furnished by the manufacturer, upon request.

★

BOOK REVIEW

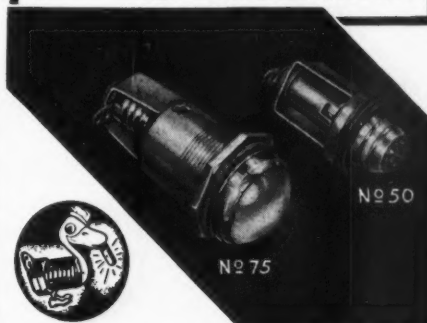
MICROWAVE TRANSMISSION, by J. C. Slater, 309 pages, McGraw-Hill Book Co., 330 W. 42nd St., New York, N. Y. Price \$3.50.

Microwaves are defined by Prof. Slater as those of wavelength between one meter and one centimeter. These waves are unique in that their wavelength is of the order of magnitude of ordinary laboratory apparatus, making possible experimental methods that are completely different from those used for any other type of electromagnetic wave. This book describes the general theory underlying the methods actually used for transmitting microwaves from point to point, from the generator in which they are produced to the receiver in which they are detected. Transmission in waveguides and coaxial lines are likewise treated in detail. The short wavelength of microwaves makes possible transmission in hollow pipes since in such cases only those waves whose length are comparable with the diameter or cross-sectional dimensions of the pipe are transmitted.

Essentially all of the scientific work on microwaves has occurred in the last ten years. Since it is such a new subject the technical literature is all too meager. In general, it may be said that microwave technique dates from the adaptation of hollow pipes and horns to microwave transmission. Not only is the transmission of microwaves possible with hollow pipes, it is practically imperative. Such waves transmitted along ordinary unenclosed transmission lines radiate more and more vigorously as the wavelength decreases, causing intolerably large transmission losses. Thus not only generation and detection but transmission of microwaves is unique.

Subjects treated in detail include Maxwell's equations, transmission lines, rectangular waveguides, the general transmission-line problem, antennas and radiation, directive microwave antennas, coupling of coaxial lines and waveguides, etc.

IT'S Performance THAT COUNTS!



PILOT Light Assemblies may look alike, but it's performance that counts! Manufacturing these small parts in the large quantities now required calls for experience, high speed production, precision methods, and materials that always meet exacting specifications. DRAKE Assemblies have been developed to their high efficiency through years of specialization. Practically every leading radio and aircraft manufacturer uses them. Demand has grown enormously yet deliveries are keeping pace with requirements. When you specify DRAKE for the Pilot Light Assemblies you need, quality and dependable performance is assured.

WILL A COPY OF OUR CATALOG HELP YOU?

DRAKE MANUFACTURING CO.

1713 W. HUBBARD ST. • CHICAGO, U. S. A.

Centralized Service on everything in Radio and Electronics

Reach for
your **ALLIED**
Catalog...

Get Everything in Radio and Electronics from this one central arsenal of supply—over 15,000 items for the Armed Forces, for Radio Training, for Research Laboratories, for War Industries, and for Service Replacement. Our large complete stocks speed delivery.

SEND FOR YOUR FREE ALLIED BUYING GUIDE

Send for the New
**ALLIED'S
RADIO-FORMULA
and DATA BOOK**

For Radio Students, Instructors, Technicians, Engineers. Contains valuable Formulas, Tables, Data and Standards commonly used in Radio and Electronics..... **10c**

ALLIED RADIO CORP.
833 W. Jackson Blvd., Dept. 14-A-3, Chicago

ALLIED RADIO

QUANTITY DELIVERY NOW

For Government contracting and sub-contracting for land, sea and other field communications devices. Types PL-54, PL-55, PL-68, JK-26, JK-48 and companion plug, and SW-141.

Universal Microphone Co., Ltd.
Inglewood Calif.

ADDRESS CHANGE?

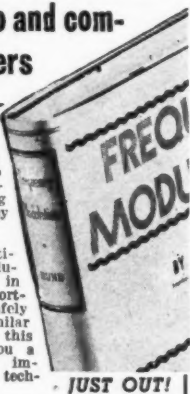
Notify RADIO's Circulation Department at 132 West 43rd Street, New York, N. Y., of your new address two or three weeks before you move. The Post Office Department does not forward magazines sent to a wrong address unless you pay additional postage. We cannot duplicate copies mailed to your old address. Thank you!

F M FUNDAMENTALS AND PRACTICES

in a well organized, up-to-date treatment for radio and communication engineers

Now August Hund, writer of widely-used radio engineering books, has prepared this thorough, dependable text to aid you in handling the specialized problems of designing and working with frequency modulation apparatus.

What are the special theoretical aspects of frequency modulation? How are they applied in existing apparatus? What shortcuts in calculation may be safely employed? These and similar questions are answered in this book, in a way to give you a working knowledge of this important branch of radio technique.



FREQUENCY MODULATION

By August Hund, Consulting Engineer
375 pages, 6x9, 113 illustrations, \$4.00

Here is an engineering treatment of frequency modulation, covering both basic principles and the design of commercial apparatus. The phenomena and features of frequency and phase modulation are described in a thorough approach that includes comparison with customary amplitude modulation, following which applications in FM transmitters, receivers, auxiliary apparatus, and antennas are fully discussed. The use of tables and curves to simplify design is emphasized.

- gives information to help in employing special design formulas in connection with band width characteristics of networks.
- gives methods of testing, useful both in designing and maintaining FM receivers.

10 DAYS' FREE EXAMINATION

McGraw-Hill Book Co.,
330 W. 42nd St., N. Y. C.

Send me Hund's Frequency Modulation for 10 days' examination on approval. In 10 days I will send you \$4.00 plus few cents postage or return book postpaid. (We pay postage on cash orders.)

Name
Address
City and State
Position
Company R.1-43

It cannot be said that the treatment is simple, yet it should not prove difficult for the engineer with a normal background of mathematics and physics. The discussions are logical and reasonably complete. The book requires study but it is well worth the effort of the engineer interested in this field.

This book deserves a place on the shelf of every radio engineer, and it is highly recommended both as a text and as a reference book.—C.F.N.

★

THE FUTURE OF TELEVISION, by Orrin E. Dunlap, 194 pages, Harper & Brothers, 49 E. 33 St., New York, N. Y. Price \$2.50.

The author, who has had some twenty years editorial experience in the field of communications, and who has published some seven books on various phases of radio, is particularly well qualified to deal with the subject of television. It is estimated that some \$30,000,000 has been spent on television research prior to 1942.

Mr. Dunlap deals with the financial, economic, legal and artistic problems confronting the television industry, rather than its technical aspects. What promises to be a billion-dollar industry is treated from the standpoint of television in the home, its role in the movies, news telecasts, its effect on the theatre, its place in instruction and teaching, program technique, etc.

Two of the most interesting chapters in the opinion of the reviewer are "The Speaking Eye Looks Ahead" and "Evolution of Television," either of which make this book most worthwhile. An interesting appendix is "Historic Steps in Television," starting with James Clerk Maxwell's prediction of the action of electro-magnetic waves in 1867, to publication of the first television advertising rate card in 1941. Such epoch events as Zworykin's filing of his original television patents, John L. Baird's first television demonstration, wire television demonstrations between New York and Washington, first transatlantic television transmission, demonstration of the kinescope, television of the English Derby at Epsom Downes, opening of W2XAB, and television at the World's Fair in New York are described.

Another timely topic is the logical discussion of "Will the Day Ever Come When Hollywood Will Take Over Television or Television Take Over Hollywood." The often-discussed topic of the effect of television on motion pictures is of as much interest to engineers as to financiers.

This book has an obvious appeal to businessmen and laymen. It is also recommended most highly to engineers

in the communication field. It is well and interestingly written and as easy to read as are most of the author's works.—C.F.N.

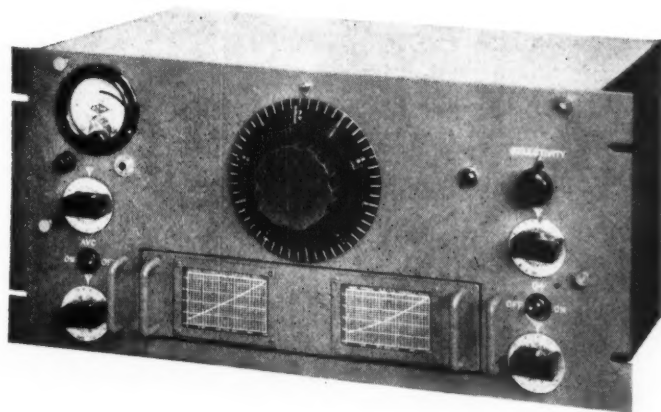
★

Books received and to be reviewed next month:

RADIO CODE MANUAL, by Arthur R. Nilson; McGraw-Hill.
MATHEMATICS FOR ELECTRICIANS AND RADIOMEN, by Nelson M. Cooke; McGraw-Hill.
A-C CALCULATION CHARTS, by R. Lorenzen; John F. Rider.
TELEVISION STANDARDS AND PRACTICE, by Donald Fink; McGraw-Hill.

ADVERTISING INDEX

Acme Electric & Mfg. Co.	61
Aerovox Corp.	64
Allied Radio Corp.	65
Astatic Corp., The	59
Bliley Electric Co.	10
Bogen Co., Inc., David	62
Bud Radio, Inc.	60
Carter Motor Co.	59
Centralab	51
Crystal Products Co.	37
Covington Lapidary Eng. Co. ..	64
Drake Manufacturing Co.	65
Echophone Radio Co.	29
Eicor, Inc.	60
Eitel-McCullough, Inc.	49
Electro-Voice Mfg. Co., Inc. ..	7
Electronic Products Mfg. Corp.	65
Erwood Sound Equipment Co.	63
Galvin Manufacturing Co.	31
Guardian Electric Co.	41
Hallcrafters Co., The	3, 4
Henry Radio Shop	56
International Resistance Co. ..	9
Jefferson-Travis Radio Corp. ..	47
Jensen Radio Mfg. Co.	12
Lafayette Radio Corp.	58
Lenz Electric Mfg. Co.	33
McGraw-Hill Book Co., Inc. ..	66
Meissner Mfg. Co.	52
Muter Co., The	61
National Co., Inc.	Cover 3
National Union Radio Corp. ..	58
Ohmite Mfg. Co.	6
O'Neil-Irwin Mfg. Co.	57
Oxford-Tartak Radio Corp. ...	64
Pioneer Gen-E-Motor	57
Presto Recording Corp.	50
Radio Speakers, Inc.	63
Shallcross Mfg. Co.	55
Sprague Specialties Co.	11
Standard Transformer Corp. ..	43
Sylvania Electric Products, Inc.	14
Thermador Electrical Mfg. Co.	38
Triplett Electrical Inst. Co. ...	34, 35
Turner Co., The	8
United States Treasury Dept. ..	53
United Transformer Co.	Cover 2
Universal Microphone Co., Ltd.	66
Utah Radio Products Co.	45
Wincharger Corporation	62
Zenith Radio Corp.	Cover 4



IF THIS WERE AN OFFICIAL ARMY OR NAVY PHOTOGRAPH...

If this were an official Army or Navy photograph it would be on the restricted list, with publication prohibited. Actually it is from the National Catalogue published before the war. Yet basically the receiver is the same. True, it is now built to government specifications rather than the amateurs'. There are new refinements that we cannot even tell you about, but which make it a better receiver than the one you have known. But basically it is still the same receiver.

When you turn to it after the war as to an old friend, you will find that it looks different, performs better and handles more easily. Yet you will find that it is still designed and built in the tradition that made a receiver engineered for peace meet the rigorous demands of war.

NATIONAL COMPANY, INC., MALDEN, MASS.



RADIONICS

THE MIRACLE INDUSTRY

Goes full speed ahead for Victory



**BETTER THAN CASH
U. S. WAR SAVINGS
STAMPS AND BONDS**

With the dawn of the New Year, we should all strive to excel—to better perform the tasks which will aid in shortening the war.

Zenith is proud to be a part of the great industrial force of this country which is producing War Radio and Radionic apparatus for our armed forces—and resolves to continue to do its utmost in producing the war equipment so vital to Victory.

Exactly what Zenith is making is a military secret, but we can tell you we are dealing with the thing we know best—Radio and Radionics exclusively.

To the millions of Zenith owners—to its many friends in the industry—to its distributors and dealers Zenith wishes the best of everything for the year to come.

ZENITH RADIO CORPORATION

Chicago, Illinois

